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Also includes Simulation Modeling info for these RCC's.

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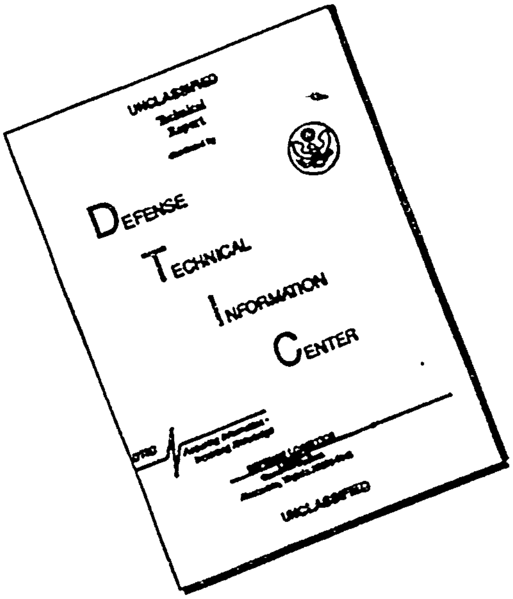

INDUSTRIAL PROCESS IMPROVEMENT-ENGINEERING SERVICES PROCESS CHARACTERIZATION TASK ORDER NO. 15

23

DATABASE DOCUMENTATION BOOK

SA-ALC

MAE & MAT

(ENTIRE REPAIR FLOW OF SELECTED GAS TURBINE ENGINES)

CONTRACT SUMMARY REPORT
14 DECEMBER 1990

CONTRACT NO. F33600-88-D-0567
CDRL SEQUENCE NO. 19A009

MCDONNELL DOUGLAS
McDonnell Douglas Missile Systems Company
St. Louis, Missouri 63166-0516 (314) 232-0232

Engineering Assessment Summary

This summary is meant to provide a clear understanding of MDMSC's analysis of the GTE repair process. Please note that the old departmental designators and skill classifications in place before the reorganization are used in discussing specific issues in this summary. MDMSC was required to study only the -180 and -397 engines in detail, and although these represent approximately 50% of the GTE workload, they do not comprise the total workload in any RCC. Where appropriate, we have included the remaining workload in our analysis and suggestions.

1.0 GENERAL OBSERVATIONS

The flowtimes for the various components parts (and therefor the end items) appear excessive, and the reject rates at both Final Assembly and Final Test are high. There is some indication that a lack of structured Quality Control measures is being reflected as early failures in the field. Although SA-ALC engineers have attempted to solve these problems, there is an almost complete absence of documentation of these efforts, or, where such documentation does exist, failure to correct the failing in a systematic manner.

The GTE repair function gives every appearance of being a production process out of control, although there are several positive influences at work in the system. GTE management maintains a visible presence on the production floor. This is a well established workload, and there is a great deal of knowledge present throughout the workforce. Many of the management personnel involved in backshop support operations claim to have been assigned directly to the GTE production task at one point or another in their career. At no point did MDMSC observe a case where process

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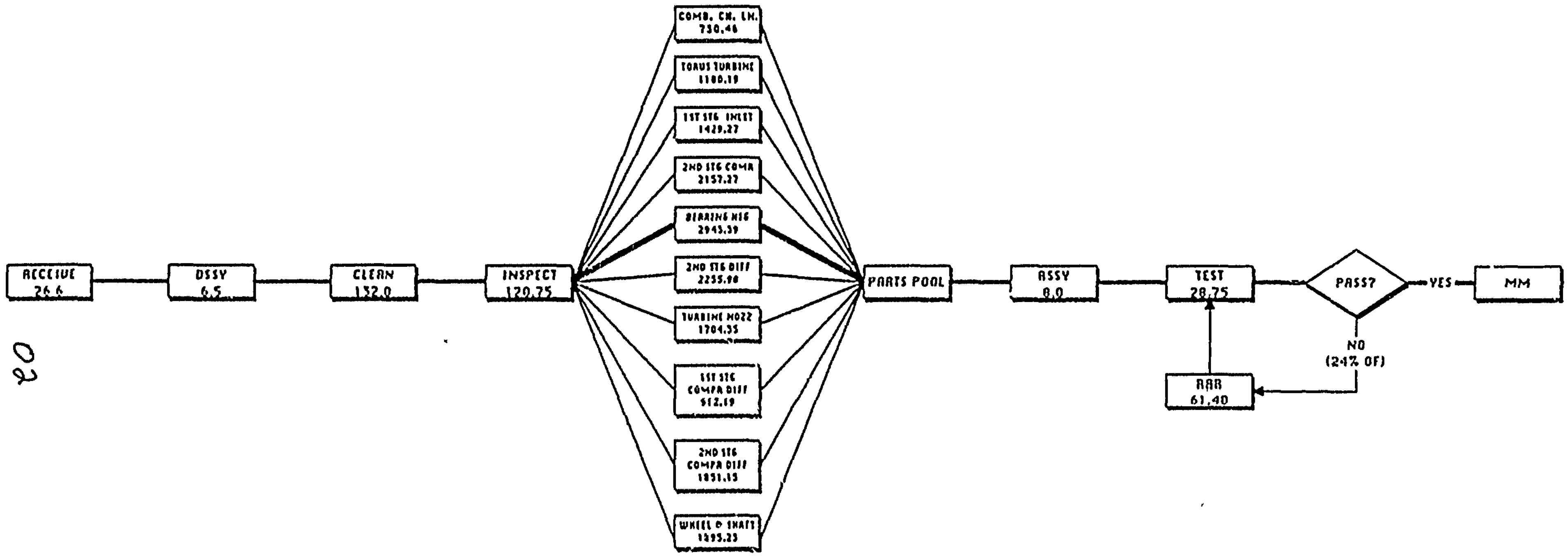
CHART 4.0.2
-180 GTE CRITICAL PATH

Process times (in hours) are shown in associated box; dark line indicates critical path.

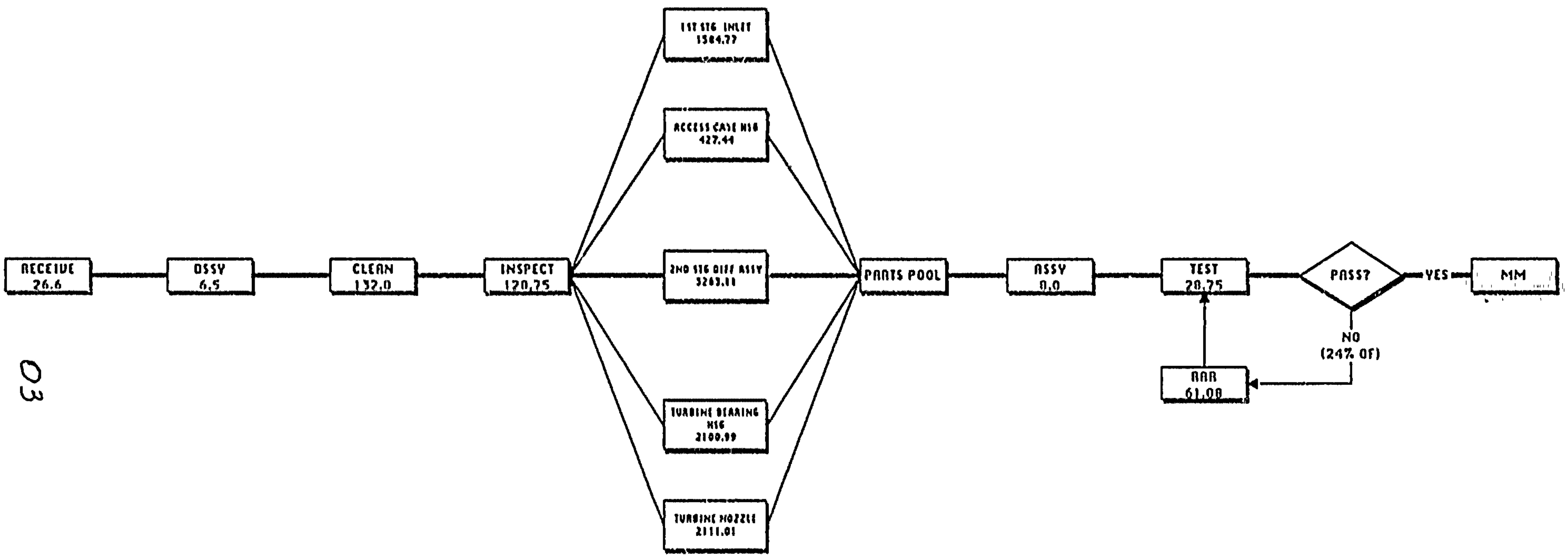


02

RAR: REPAIR AS REQUIRED

CHART 4.0.3
-397 GTE CRITICAL PATH

Process times (in hours) are shown in associated box; dark line indicates critical path.



03

RAR: REPAIR AS REQUIRED

problems could be directly linked to lack of training, or to a failure to follow existing technical directives. Unfortunately, personnel tend to adhere to established ways of "doing business" without regard for the effectiveness of their actions. Any item which requires repair ages, and the nature of the repairs needed change, as well as their frequency. This demands change workforce practices.

One analogy, provided by the MAT division chief, sums up the GTE process quite well: A sausage grinder. If you push enough meat into one end of the grinder and turn the crank, you are sure to get something out the other end eventually. In this case, however, the output cannot keep up with the input, and a serious imbalance, in the form of high WIP, results. The analogy can be taken one step further. As with the grinder, if you want to increase output, you have to turn the crank faster. In the GTE repair process, when there is a shortage of a particular component, there is a tendency to hand carry or otherwise expedite the item through the system. This is disruptive of normal production, and obviously a labor intensive solution. Worse, it does not appear to be particularly effective. The various RCCs, especially backshops, appear to be fairly robust to pressure such as this. "Turning the crank faster" does not seem to work.

The following paragraphs will provide a more detailed discussion of the above points, along with MDMSC's recommendations and observations on the subject.

2.0 FACILITIES, PERSONNEL, AND EQUIPMENT

The GTE repair process is spread throughout several buildings. It also crosses division lines (or company lines in the reorganized system). The operations directly under the GTE managements control are mainly located in buildings 329 and 340, and involve disassembly, cleaning, inspection, assembly, and testing functions. The existing facilities appear to be adequate to support these requirements, at the present workload. One exception would have been the cleaning line present in building 329. This line was in an obvious state of disarray, and was considered a process bottleneck in Task Order One. However, the new cleaning line, located in the same building, is currently being brought up to operational levels. Based on information we were given, this should provide greater production capacity, as well as provide better quality at this stage of the process.

We have also been requested to examine the existing FPI line for possible improvement suggestions. It appears that this line is providing production capacity sufficient to maintain present requirements, but automation of the system might enhance its operational efficiency. The degree of automation required would depend on future workload requirements, which may include items other than GTE components. MDMSC was provided a copy of a REPTECH proposal which requests funding for a rather elaborate automatic inspection system. This proposal, as well as supporting data collected by MDMSC site personnel, was sent to St. Louis for examination by a MDMSC in-house specialist. The results of this individuals' recommendations will appear in the CSR.

Most other equipment present in the two primary production facilities appears adequate. The automated test equipment found at Final Test, on the other hand, is worthy of special praise. This equipment provides a very thorough diagnostic check of an assembled GTE. This is an automated system which, although it does require operator input and observation, increases both the quality of the end item and reduces the amount of direct labor needed to achieve this quality. Conversely, the equipment used in assessing the balance of rotating components appears inadequate to the task. This subject will be addressed in more detail in the section covering rejections.

Personnel requirements necessary to the present production process appear adequate, both in number and in required skills. The model indicates that personnel in all areas are adequate (when the remaining 50% of GTE workloads are calculated into the results). The personnel assigned to MATPSI inspection appear to be highly utilized, and considering the entire GTE workload this area could represent a process bottleneck. At present I would not consider this a problem, however, as the system contains a great deal of work in process, and production does not appear stressed at this level.

Again, our judgement of the adequacy of the facilities, personnel, and equipment are relevant only to the existing process parameters. In order to obtain a more efficient production process, several changes in these areas will be necessary. I will discuss various MDMSC's observations and recommendations regarding these changes in Section 4.0 of this summary.

3.0 SUPPORT FUNCTIONS

There are various support functions associated with the GTE repair process. We concentrated our attention on engineering, planning, and scheduling functions, as these have some responsibility, along with production management, for meeting production goals.

The GTE repair process suffers from a deficiency common to most other AFLC processes: Not enough trained engineers for the production workload. The engineers that are presently in the system are usually given so many tasks that they can not concentrate fully on any one project. The results are as expected; most of them spend the majority of their time "putting out fires", that is, expend the amount of effort necessary to just keep things running while trying to juggle all the other demands on their time. Worse, since there is a shortage, many of the engineering personnel end up performing a multitude of paperwork tasks, such as developing new proposals or Statement Of Work (SOW). These duties keep the engineers away from what should be their primary focus.

There appears to be a serious lack of documentation of tasks performed by engineers regarding their analysis and recommendations on process problems. We have encountered this several times, and most noticeably in relation to the GTE vibration problems, which appears to have some historic significance in this process. Management should insist on a thorough documentation of the analysis and recommendations relevant to process problems under study. Management should also insist on a complete cause-and-effect analysis of any proposed solutions to a specific problem.

Planning functions were examined in some detail, as we made much use of the ALC labor standards in both the model construction and process analysis. The main points of contact in planning for this Task Order appeared extremely knowledgeable, and were involved in the daily floor operations of their respective areas of responsibility. Other personnel encountered in this support function displayed similar competence.

While I would rate the planning functions of these areas as quite high, I would mention two potential problems that we identified. The ALC labor standards, which reflect the amount of labor hours paid for processing various parts, do not well agree with shop interview times. In almost every case the interview times were higher. Our Task Order contact in engineering was extremely uncomfortable with interview data, which is why documented historic data and ALC labor standards appear throughout the model files. Still, only 20% of the labor standards represent "engineered" standards, which MDMSC considers too low for a process such as this. The remaining "non-engineered" standards, although they may be close, undoubtedly contain inherent inaccuracies. I am not suggesting that every .abor standard be produced by "time study" (in fact, I would advice against the use of the time study procedures I have seen used in ALC planning procedures), but some form of easily reproducible methodology should be applied to labor standard creation. It is advisable to perform work sampling on various items throughout the year in order to establish standards. This has the additional benefit of providing insight into process problems in the area of quality, both integral to the process as well as due to vendor supplied items.

The other area of concern lies in the structuring of the WCD operational format. Both of the GTEs we analyzed had detailed WCDs for most parts, and the quality of these WCDS was superior to any I have personally seen before. There is a great deal of variability between WCD format, however, which appears to be based mostly on the individual planners' ability to produce these documents. This has been true of the other ALCs that have been examined. Standardized formats should be developed which provide the correct sequencing and level of details.

The scheduling functions which we examined have much room for improvement. Items do not flow smoothly through the system, and there are frequent shortages. The relatively high reject rate at final assembly and final test contribute to the problem, but the backshops are the primary problem. The backshops appear fairly unresponsive to the needs of GTE production management, especially when crossing divisional lines.

The scheduling functions at the floor level appear to be undermanned. Scheduling does not have ready access to information regarding how many parts are actually in process, or where these parts are located. A rigorous audit of GTE components should be performed, involving all areas of the repair process. This would provide a count of how many items are presently in the system, and what stage of production they are in.

Finished parts are currently loaded into baskets for transport to parts pool without first applying protective wrapping. This is especially important given the critical surface characteristics of some of these parts.

The basis of a good scheduling system is a disciplined work force, which does not appear to be found in the GTE repair shops. The actual culprit in this is the multitude of backshop operations not directly under GTE managements control.

4.0 PROCESS FLOW: PRIMARY, BACKSHOPS, AND CRITICAL PATH

The bulk of the flowtime for GTE components reside in the backshop operations. Of the backshops examined, the Machine Shop (MATPNC) appears to contribute the most significant delay times to the overall repair process. On the other hand, the FPI inspection area associated with this machine shop (MATPNB) shows the lowest delay times of any RCC analyzed. The other RCCs examined lie between these two extremes.

The process flow diagram produced during last year's completion of Task Order One is still current. An abbreviated version of this flow diagram is shown in Chart 4.0.1. This chart shows the basic flow of items through the GTE repair process. Charts 4.0.2 and 4.0.3 provide a graphical depiction of the critical paths for both engines as well as the associated flowtimes. A more detailed comparison of the model results, historical documentation, and parts tracking data is shown in Table 4.0.4 (The spreadsheet format and analysis data for the parts tracking effort are shown in Appendix A of this summary). The following is a brief discussion of the various main process areas for GTE items. In the case of backshop functions, I have attempted to identify those processes which would be prime candidates for moving in-house. This is a practice which I would strongly suggest, given our perception of problems relating to excessive flowtimes and quality deficiencies.

SIMPLIFIED GTE FLOW DIAGRAM

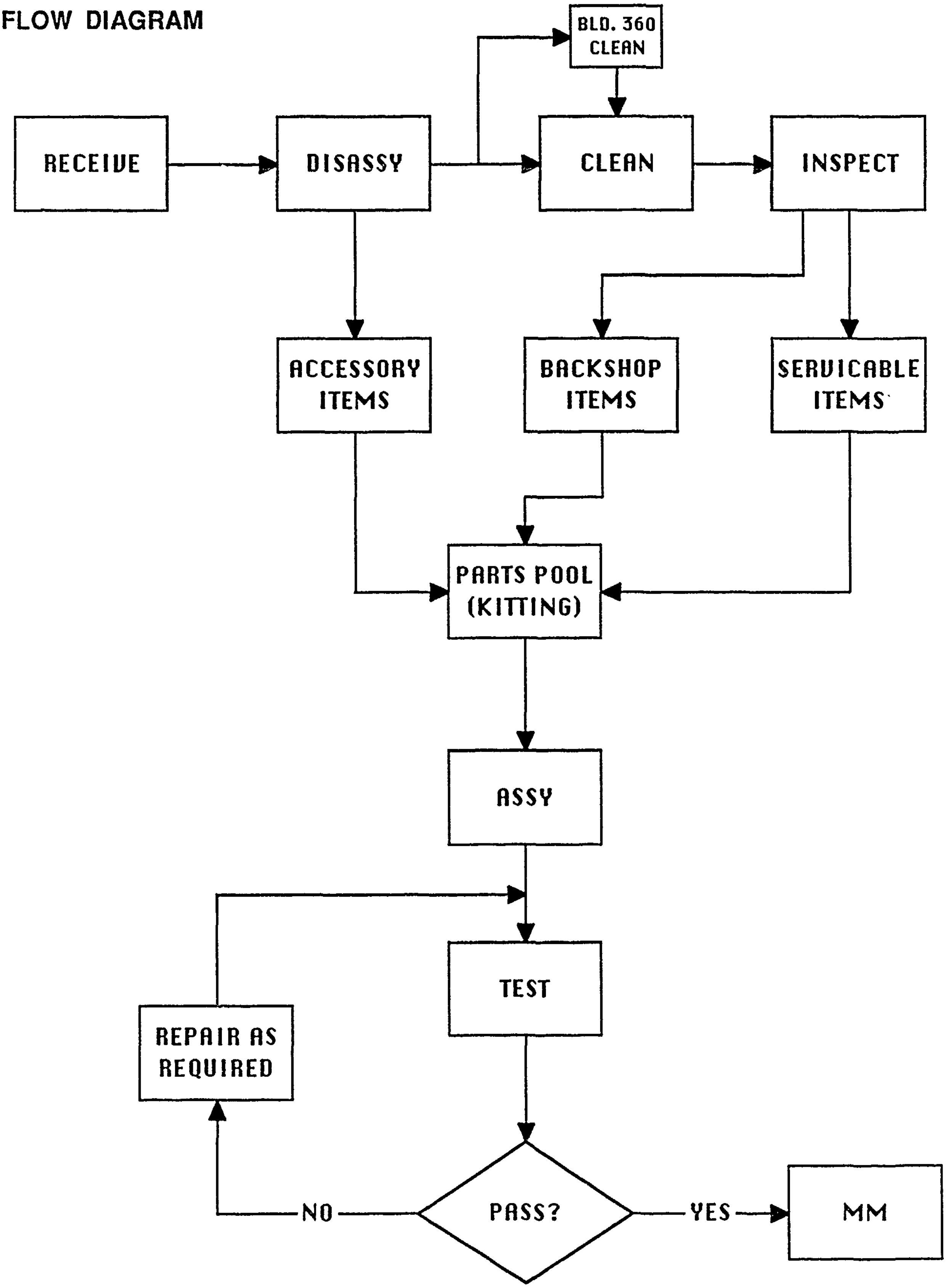


CHART 4.0.1

4.0.1 MATPGB - DISASSEMBLY

The GTEs are uncrated, logged in, and then brought into the bld. 329 disassembly area. There are a total of nine personnel assigned to this task, and these are assigned to one shift. Two of these personnel are grade WG05, and primarily used in the uncrating and logging of items. Facilities for disassembly appear somewhat cramped. There appears to be no shortage of disassembly fixtures.

Disassembled components are loaded into modules and routed to building 360 for the initial cleaning process. Parts sent to bld. 360 tend to take approximately seven days (this includes weekends) to process, although the actual cleaning of a module is a matter of a few hours. I strongly suggest that measures be taken to perform all cleaning in-house. This will be discussed in more detail below.

It is interesting to note that six of the nine personnel assigned to this area are grade WG10s. Conversely, of the six individuals assigned to the assembly of GTEs (and having the same job classification), four are WG09. This seems surprising, as it would appear that the higher skilled personnel should be assigned to final assembly, where there is less room for error in the repair process.

4.0.2 ACCESSORY ITEMS

There are various accessory items associated with both the -180 and -397 engines. These items include tach generators, air pressure regulators, load valves, oil pumps, fuel controls, and various other components. These components range in processing times from one to 8.5 hours, with the average component part requiring approximately 5.0 labor hours to repair. The actual dwell time in the repair areas can vary greatly from this, however. In our analysis of the accessory repair RCCs we did not see any indications that GTE final assembly would be delayed awaiting these components. Still, GTE production management should maintain a close watch on the production of these items.

These RCCs suffer from a common failing found throughout the GTE repair process: Unrealistic scheduling practices. These RCCs, like many others we examined, are provided with a schedule of their required production for a given period. They also have access to the schedule for end item production for that period. The number of end items to be produced is often significantly less than the number of individual components which were requested by scheduling. It is not surprising that parts pool often receives only enough components to support production of the scheduled end items. Unfortunately, decisions such as these, made at the production floor level, do not take into account management's production goals or the high rejection rates of both component items and the end items. The end result is that end item production quotas are not met.

There is a negative feedback involved in this practice. As only the minimum number of parts are provided to parts pool, more end items (which serve as a source of spares) must be inducted into the system to maintain the GTE production schedule increase. This, in turn, prompts Scheduling of the high individual component quotas, making the production areas even more insensitive to what they regard as "false" scheduling. This is a practice seen in many of the RCCs examined, and is not restricted to the accessory repair areas.

One other problem observed in the accessory repair RCCs is an historical lack of spares. There was also a tendency to process GTE accessory components in rather large batches, with the associated delays in acquiring these batch sizes. While this does not appear to be a problem at this time, GTE management would be wise to monitor the situation should other areas of their process be made more efficient.

4.0.3 **MATPSI - CLEANING**

This area of the GTE repair process has been greatly improved. The new line will offer significant improvements in the cleaning processes performed in-house (based on information recently provided to us.) There are some signs that contractual specifications for this line have not been met, which could affect its performance. It does not appear that the line will remove the need to send parts to bld. 360 for initial cleaning. This seems inefficient, and we recommend an alternate strategy.

MDMSC has examined two manufacturers of cryogenic blasting equipment; the Alpheus and Cold Jet companies respectively. There is a potential for use of this technology in the cleaning functions found in MATPSI. Although it would require a detailed study to be certain it seems likely that components could be cleaned in-house without the need of routing to bld. 360. This assumption is based on the results of MDMSC's direct observation of GTE components cleaned at the Cold Jet facility in Ohio. Our suggestion is somewhat tempered by the cool response it received by Roger Kiker, who is one of the MATES engineers charged with setting up the new cleaning line. His objections centered on the fact that they have spent five years in getting to this point on the new system (due to funding issues), and he feels that it is more important that shop personnel "learn to use what they have now". If the cryogenic blasting technology has something to offer in this regard, it should not be dismissed due to frustration over funding cuts or deficiencies in shop practices.

4.0.4 **MATPSI - INSPECTION**

This area has the potential to be a bottleneck should production quotas rise much beyond present levels. This observation is based on the results of the simulation model runs we have performed, and extrapolating these results to include the rest of the GTE workload. At this time, inspection appears to meet present production demands.

Many of the inspection tasks in this area are performed on automated dimensional inspection equipment, which increases both the accuracy and ease of the operation. Personnel seem knowledgeable as to their appointed tasks.

Some parts, which are inspected and found to be within tolerance, are still routed to backshops, especially the machine shop. This represents a significant inefficiency, since the machinists must then repeat the inspection using hand equipment. It appears, in at least a few cases, that the tolerances and specifications given in the machinist's technical directives are tighter than those of the inspector's criteria. This means that certain serviceable parts are being reworked without cause. The increase in flow time of the affected part is unacceptable, but worse, the wear on the part from subsequent machining, plating, welding, etc. significantly lowers the life cycle of the component. If this practice of routing parts is the result of adherence to WCD operation sequencing, inspection personnel should be trained in the correct procedures for sending parts directly to parts pool. If it is the result of personnel passing off certification of acceptability to another shop, then the situation should be stopped immediately. In any case, the degree of serviceability of specific parts returning from the field is very valuable information, and should be closely monitored. It is poor production practice to have looser standards in an initial inspection operation if it is to be automatically followed by a repair operation having tighter tolerances. This removes the value of the inspection operation in the first place.

Personnel knowledgeable with machining practices could be the best source of inspection personnel, as these individuals often understand the concepts of overall tolerance build-up and specifications better than many others. Experienced machinists should therefor be considered as a good source of future inspection personnel.

4.0.5 MATPNC - MACHINE SHOP

The machine shop located in bld. 303 is responsible for machining process related to aircraft, aircraft engines, and GTE component repair. The GTE workload in this area has its own dedicated equipment and personnel.

This area has an efficient layout. It is well lit and clean, and items are neatly organized on stainless steel racks located throughout the shop. These racks are an excellent addition to the area, and make it very easy to tell how much work in process (WIP) is present. The fact that certain racks are dedicated specifically to in-coming and out-going parts makes material handling much easier, and contributes to the fact that material transport and handling practices in this area were relatively efficient.

The fact that it is easy to determine a rough count of WIP by looking in the racks is important, as the amount of WIP present is substantial. This helps account for the lengthy, historically documented flow times in this area. This flow time does not have much to do with the actual processing of items in this area, but more with a lack of structured production goals for this area. The individual machinists produce only the number of items necessary to meet the minimal production quotas for GTE end items for each month. On the other hand, they receive a significantly larger number of individual components (due to over-inductions) than they produce in a given month. This allows them to choose which components they process. Since they do not have a first in, first out system, items become buried under ever increasing WIP, which contributes to the quality problems in the GTE process. Items which are rejected at final assembly may circulate through the system, continually, as no records are kept.

In many cases, both personnel and machines are dedicated to a particular component. There are some advantages to this, as it is unnecessary to set up and tear down equipment in this system, and personnel become very knowledgeable as to their specific function. It is unusual that such an abundance of equipment and personnel exists in a shop of this type. At the least, there is some loss of flexibility, both in personnel and production capability, under this system. They have created a virtual GTE machining cell.

Given the historically long flowtimes associated with this area, I would recommend that as many items as possible be moved to an in-house machining area, directly under GTE management's control.

4.0.6 **MATPNB - FPI**

This area is located in building 303, and performs non-destructive inspection of a variety of items, including GTE components. This backshop function proved to be one of the most efficient at processing items in a timely manner.

The same inspection capability presently exists in-house for the GTE repair process. If machining an/or other repair processes were moved in-house to bld. 329, the existing facility could be used to process the workload now performed in bld. 303. This would result in lower flowtimes, and would provide more control of the process to GTE management .

4.0.7 **MATPNN - WELDING**

The GTE components repaired in the welding shop also exhibited long flowtimes. Many of the same problems dealing with lack of structured production goals and over-induction also apply to this area. There appears to be a large amount of WIP, most visibly involving various GTE Turbine Torus. (It is interesting to note that the various turbine torus show a low condemnation rate; I wonder if this has more to do with the fact that these items are setting on racks in MATPNN as "difficult-to-repair items" than the actual condemnation rate of these items?)

Welding tasks divide into two major categories: Build-up processes, including plasma spray, and general sheetmetal repair. The build-up processes are usually closely associated with machining practices, and any movement of parts to an in-house machining process would require associated welding support. I recommend that welders having plasma spray and other build-up capability be located in close physical proximity to the in-house machining area. This would provide a much quicker turnaround of components requiring rework.

4.0.8 MAEPDB - HEAT TREAT

For the most part, items sent to heat treat did not exhibit excessively long flowtimes, as this area maintains two shifts. Given the nature of the equipment found in this area, it would not be practical to bring this capability in-house to the GTE repair processes found in bld. 329.

4.0.9 MAEIAA - PLATING

The greatest percentage of plating operations performed on GTE components in this RCC involve anodizing processes. These require pre-cleaning, masking, and a relatively simple tank process, all batch operations which do not require the same items be processed simultaneously. Since this area does show long flowtimes, the possibility of moving a simple anodizing process in-house is recommended. The process currently used, is a "barrel" plating operation, and would lend itself to in-house placement with minimal facilities and equipment requirements. The other plating process examined, including chrome plating and hard coat anodizing, should remain in the MAEIAA.

4.1.0 PARTS POOL

I suggest that the kitting operations currently performed by parts pool be abolished. To replace this operation, I would suggest that silhouette boards, such as those suggested at recent meetings with Mr. Gonzales, be implemented. These boards would have the required components' silhouette and/or name placed on them, with some color coded scheduling status displayed for each part. The boards could be placed in assembly areas, and the result would be a graphical depiction of the status of each part required for a particular assembly. This would be an excellent management tool, as it would indicate at a glance the status of items required for production. The response to delayed items would be quicker given this visibility.

4.1.1 MATPGB - FINAL ASSEMBLY

Many of the suggestions made above have been designed to provide GTE components to final assembly in a more expedient manner. The use of lower skilled assembly personnel in this area seems a bad practice. The end item is assigned a serial number only at this stage of the production process. It therefor seems confusing that data such as that found in the GO19C (repair time, repair cost, etc.) could even be collected, much less tracked or used. This is only one of the reasons that MDMSC has recommended in the past that GTE components be serialized, processed, and assembled as a unit.

4.1.2 MATPGB - FINAL TEST

Final test of the GTEs utilizes a very impressive automated system. Most of the problems here are caused by the unbalanced production schedule (which causes queuing for resources at certain times of the month followed by relatively slack periods at other times), and the high amount of rejects which occur at this stage. The following histograms, Charts 4.0.5 and 4.0.6, give an idea of the time required to process items from the date they are serialized (upon delivery of kit to final assembly) until they are delivered to MM.

180 KTS FY 90 (CHART)

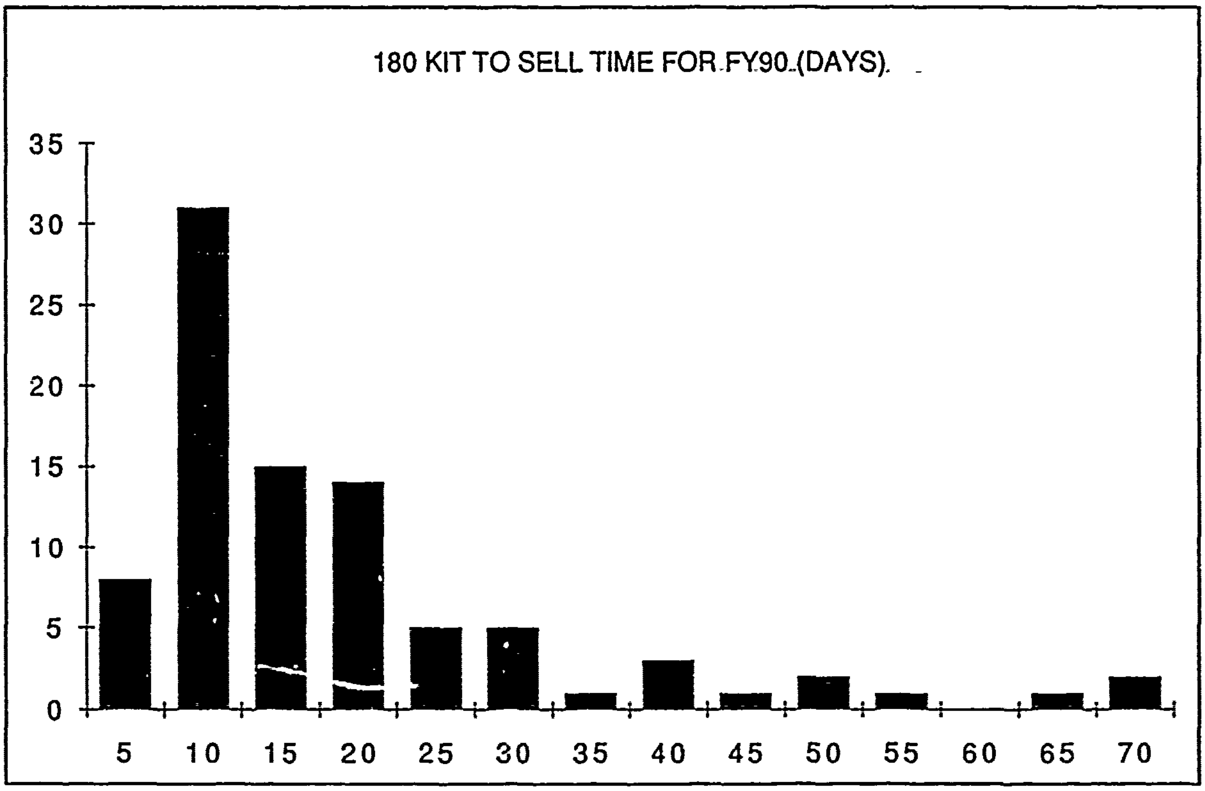


Chart 4.0.5

397 KTS FY90 (CHART)

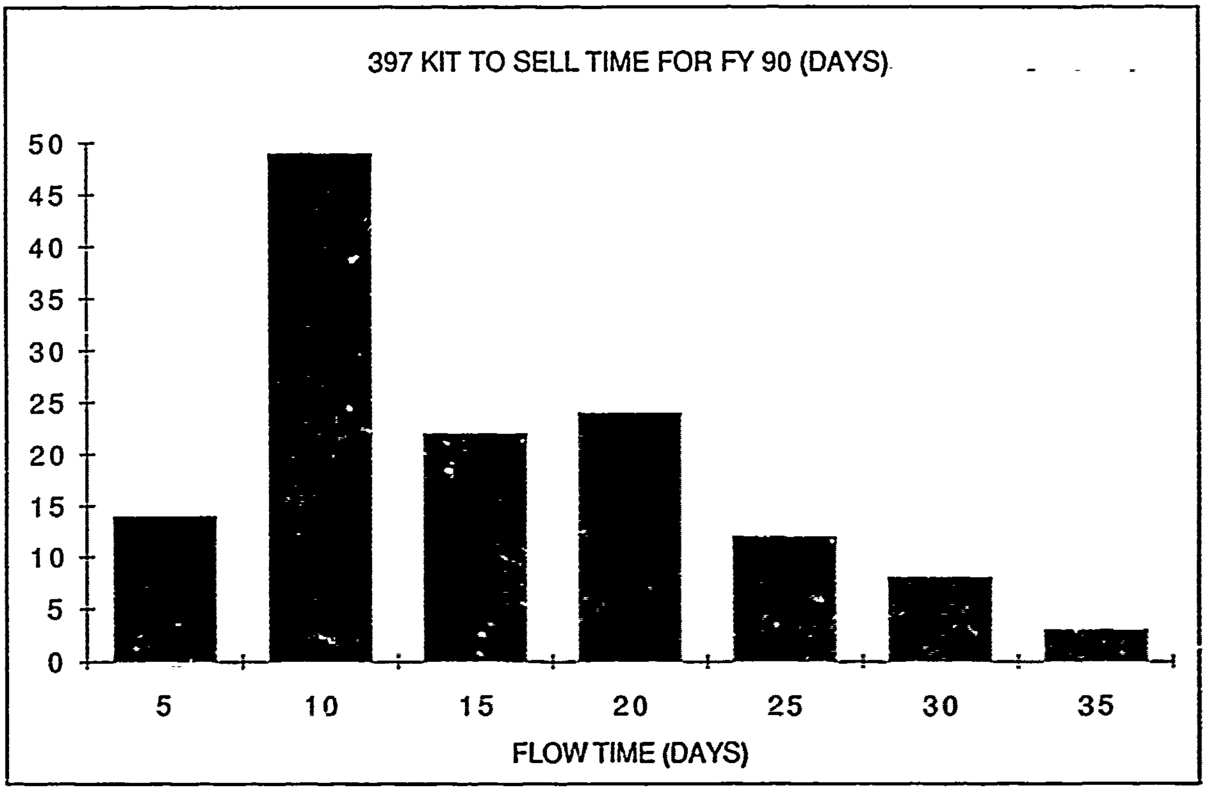


chart 4.[illegible].6

5.0 REJECTION/REWORK ANALYSIS

This Task Order has been somewhat unusual given the relatively large amount of data which exists in various databases and log books found throughout the process. These have been invaluable in our efforts, and we recommend that a concerted effort be made to draw all of these disjointed records into a comprehensive whole. These sources of information have been especially valuable in our analysis of quality rework and rejection rates. Most of the sources for the data we will discuss below have been mentioned in our engineering notes at one point or another. The data was mainly drawn from the automatically collected test statistics of the test cell, the rejection logs maintained by final assembly, the induction log maintained by the receiving personnel, and various databases provided to us by the planners.

Rejections at final test have a variety of causes. These are broadly defined under the categories of Removals, Internal Failures, Improper Cavity Pressure, and Vibration. Vibration problems are usually caused by imbalance in the compressor sections of the engine, but can also be caused by imbalance in the turbine or accessory case, bad bearings, and misalignment. Cavity pressure problems are usually due to to bad seals or clogged return lines in the oil sump systems. Removals are related to performance problems of the engine during testing. Charts 5.0.7 and 5.0.8 show the historic occurrence of each of these categories of failure since 1987. For 1990, we have determined that the overall reject rate at the date of our analysis (9/30/90) to be 24% for both the -180 and -397 engines. In both cases vibration accounts for approximately 50% of the observed rejections. The increase in rejections of the -180 engines is especially alarming, as it appears that the percent of rejections due to vibrations has shown a steadily increasing trend.

180 REJECTS (CAUSES)

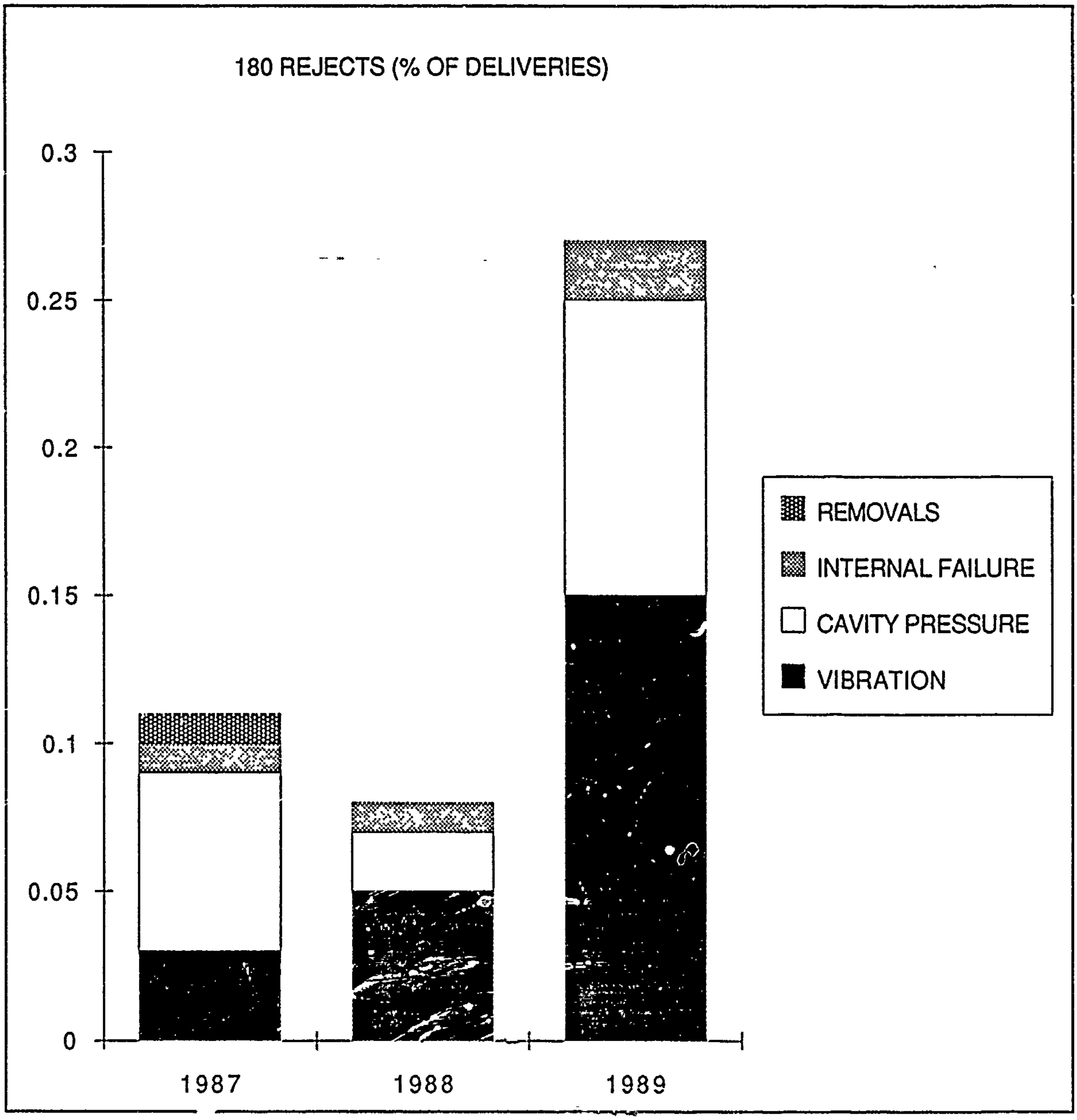


chart 5:0.7

397 REJECTS (CA ES)

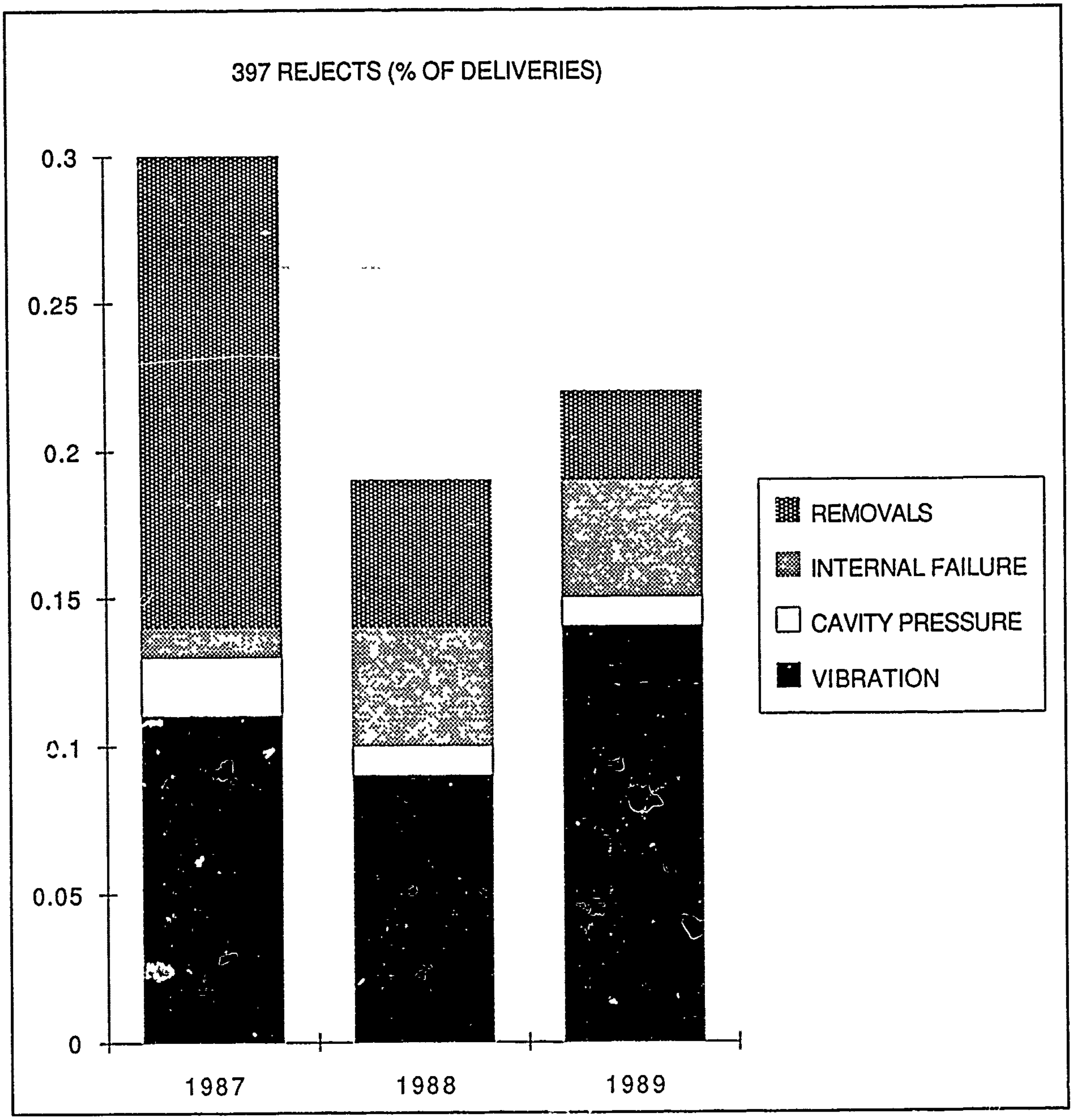


Chart 5.0.5

These rejection rates are unnecessary in any modern industrial process. They point to either a severe quality problem, or a design flaw in the engines themselves. Since these engines have been in the inventory for many years, we must assume that the GTE repair process is itself somewhat to blame. While most personnel associated with the process admit to historic reject and rework problems, there is very little documentation as to how these problems have been addressed in the past. I would strongly urge the GTE management and engineering functions to insist on careful documentation of not only the amount and cause of rejects, but also the careful documentation of all attempted solutions to these problems, including a detailed cause-and-effect analysis for all proposed solutions to specific problems. As to the type of data that should be collected, and the manner in which it should be reported, the contract summary report will contain specific examples in a recommended format.

This rejection/rework problem is extremely costly in both labor expended and lowered production capacity. For example, Charts 4.0.5 and 4.0.6 indicate that the time from issue of the GTE serial number at final assembly until delivery to MM range from five to 70 days for both engines, with the average for the -180 being 15 days and the average of the -397 over 17 days. The assembly of the engine and its subsequent testing, on the other hand, should require only two or three eight hour shifts at the most. We assume that at least part of the 12 to 15 day average delays is attributable to rejection and rework at final test. The problem is much worse than a simple delay would indicate. We assume that components which are found to be at fault are removed from the engines, and these are then returned to the repair process. Many of these failed components are circulating repeatedly through the repair process, passing through the various inspection points, and being returned to assembly. There is no first in, first out system in effect, and a relatively small percentage of "bad actor" parts can contribute a disproportionate amount of work to the process.

In examining the clock readings of GTEs returned to the depot due to failure in the field, we observe that 41% of the -180 engines fail in less than a 1000 hours of field usage. The -397 has an even worse record, as 44% of all engines fail in less than 650 hours. At 2500 hours of field usage, less than 28% of the -180s are still functional, and only 13% of the -397 are operational. Charts 5.0.9 and 5.0.10 show histograms of this data in graphical form, over a period of the last four years ('86 to 1990). The failures group to the left of the mean, with a large number of engines failing in less than 500 hours of field usage.

This data indicates that every stage of the GTE repair process needs quality assurance procedures. A very careful study of how these products are performing in the field should be undertaken. If the engine designs themselves are to blame, it may be more cost effective to replace both of these items with more reliable engines. The need for detailed documentation of the relevant data is absolutely critical to solving this problem.

6.0 SUMMARY

I would recommend as many of the backshop processes be brought in-house as possible. These should not be limited to strictly the machining processes, but should include the location of welding facilities, as well as FPI capability, in close physical proximity to the machining operations as well as anodizing tanks and related process equipment.

A structured scheduling system should be implemented, with the end goal of significantly shortening flow times as its objective. To facilitate this goal, a strict audit of all items currently in process should be collected, and all unnecessary WIP should be collected from the backshops. These items should be released to the backshops on a very strict schedule. A system of personal accountability for both maintaining this schedule and required quality procedures needs to be implemented.

A structured, Statistical Process Control and Quality Assurance system should be implemented immediately. Critical process and operational parameters should be identified and tracked under this system. All potential process improvement suggestions and actions should be carefully documented.

-180 FEILD FAILURE DATA
(SAMPLE SIZE: FOUR YEARS)

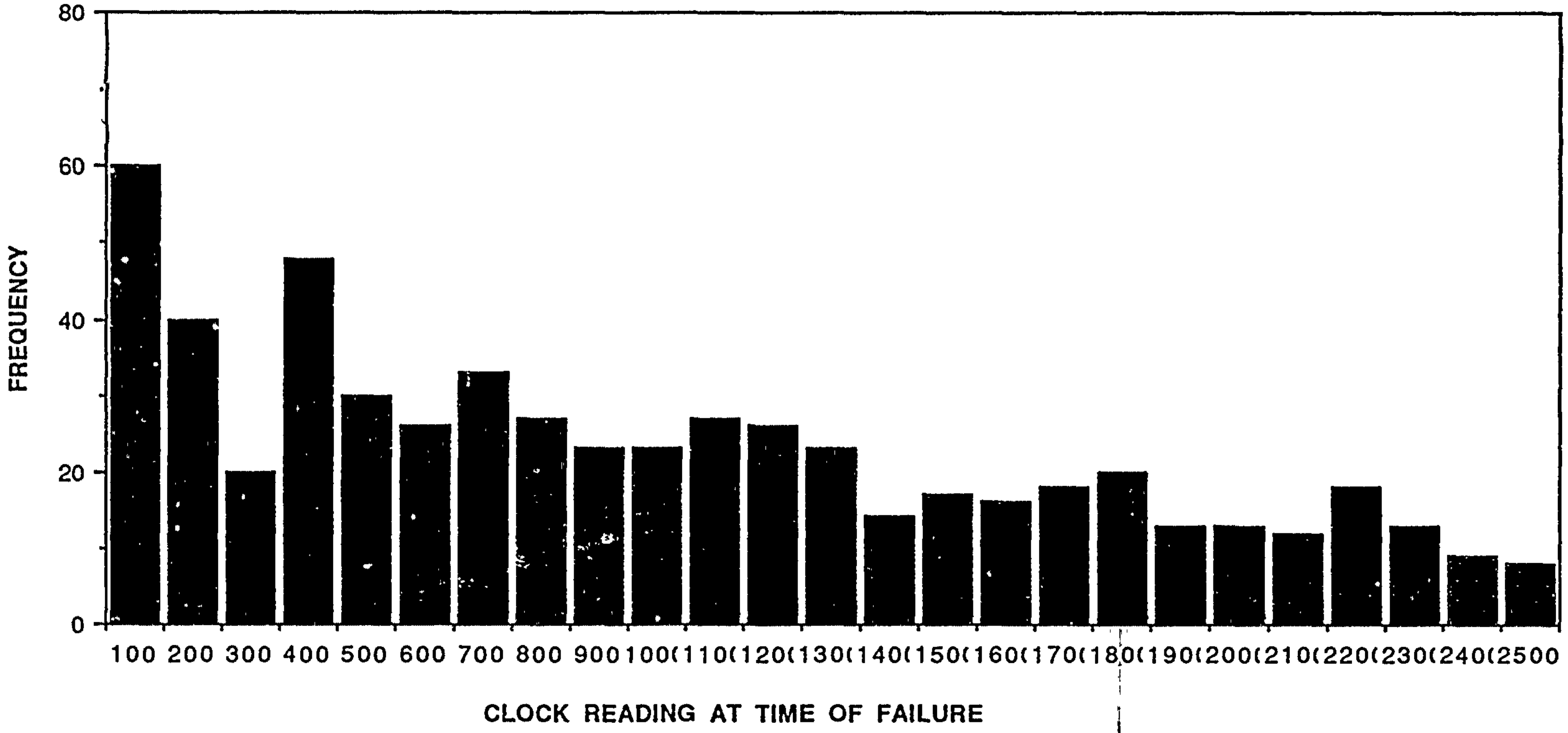


chart 5.0.9

-397 FIELD FAILURE DATA
(SAMPLE SIZE: FOUR YEARS)

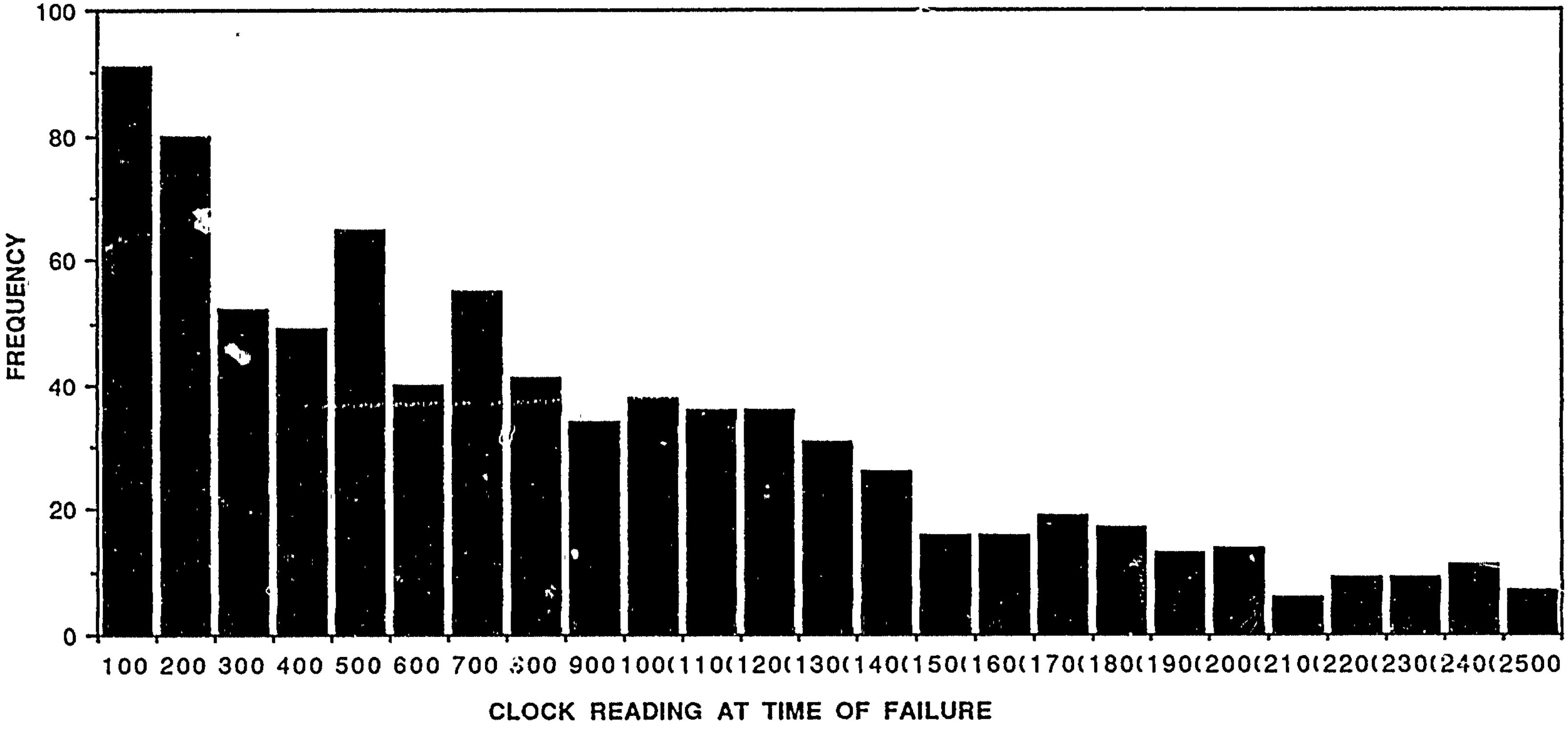


chart 5.10

ENGINEERING NOTES

EMPLOYEE Parker DATE 7/26/90 PAGE NO 29
RCC GTE (All) SUBJECT GTE general info

I mentioned to Danny that we would be interested in being of assistance in his task of implementing this system, within the constraints of this program. Mr. Gardner has offered to contact the MDMSC personnel in charge of the DOIS system, if Danny would care to be briefed on their experiences with large, interrelated tracking systems. There may be some important lessons learned in the construction and functioning of this MDMSC system, which is used to track missile production in the Harpoon Missile Depot.

Danny also answered several questions we had in relation to various GTE processes we are studying. The in-house machine shop which he is setting up will contain five lathes and three radial drills. The workload to be transferred is mainly the shortstack machining operations. We will need to determine what percent of this workload will be transferred from the main machine shop, as well as the flowtimes associated with the main operations involved. The delays and transit times for these items will also need to be defined, as these will necessarily change when the operations are brought in-house. We will need to collect these data elements if we are going to include this proposed "RCC" into the model.

I also spoke with Danny about certain data collected in the MATPSI RCC in T.O. One. There were several areas where I was unclear as to what was trying to be accomplished. He suggested that I speak with Ed Gill (54323), who is the planner for this area, and who was also instrumental in validation of this area last year.

Danny also also suggested that I contact the planners for the two GTEs we are characterizing in order that we might identify the critical parts in the production processes, and how these items should best be tracked and analyzed. The planner for the 180 engine is Dan Heyward, and for the 397 engine we should contact Brent Castle (Gilbert Segura may be alternate to Mr. Castle).

DDB SECTION CODE 5.0 DDB PAGE NO.

ENGINEERING NOTES

EMPLOYEE P. Parker DATE 7/16/90 PAGE NO. 17
RCC GTE - All SUBJECT General info

7/16/90 - Monday

The GTE Task Order was to begin today, but due to the heavy downpours here the base is closed to non-essential government personnel until noon. I will try to contact the necessary personnel to set up a tour for the GTE area tomorrow morning.

The following is a list of proposed tasks which I feel need to be accomplished in order to successfully meet our base contract needs:

T.O. #15 GTE Repair Processes
Turn-on date: 7/16/90

TASKS -

* denotes in-work
? denotes a to-do
<u>! denotes a finished item</u>

? determine if we can identify the major tasks that any one GTE could go through.

? determine what the critical path is for the GTEs to be studied. (Is there a logical grouping of major components or subassemblies which will help us define this critical path).

? Build flow charts with associated times and occurrence factors.

? identify those branch and/or decision points where we may need to collect sample data.

? identify the skill codes and quantities for the various RCCs. Contact Suzie Guzeman to determine manpower availability for this area (all shops). Note: Randy may want to go with us.

? determine which resources are necessary to characterize flow for 1st model run.

DDB SECTION CODE 1.0 DDB PAGE NO. ____

ENGINEERING NOTES

EMPLOYEE P. Parker
DATE 7/16/90
PAGE NO. 18
RCC GTE - All
SUBJECT General Info

? determine MTBF/MTTR for all equip (database?).

? Naming conventions for item profiles and ops profiles. How user friendly are the conventions used in T.O. 1 work?

? Determine the last 12 months inductions and the last 12 months throughput. (Any way to get a grasp of how many GTEs are residing in their parts pool?)

? talk with Danny and get the details on how he plans to approach the GTE parts tracking system. What does he plan to use for identifiers? Does he have a format for his collection system/forms? How is he going to track between functional areas? What can we do to help?

? What are the needs and expectations of the machine shop as regards this Task Order? Are they talking about the dedication of machines to certain workloads, or the more classical "flexible cell" concept? (sounds more like cellular groupings to me).

? How well will MATPGB ops profiles lend themselves to more logical (lesser detail) groupings?

Basically, we plan to approach these RCCs as a single entity, interrelated in their production of the various GTE components. I agree that the best method is to choose only the driver items to track for the higher order model run. I suggest that we take the flow chart that was previously produced and attach both flowtimes and occurrence factors, after identifying the major assemblies and/or critical path components. I would like to set as a goal that we have at least one model run by the 20th of August. "If" subsequent runs are necessary, we should try to make them no later than two weeks after the previous run (i.e.; 9/4, 9/18, 10/2, which should easily allow us to meet our 10/9/90 validation deadline in the thirteenth week of this task order).

DDB SECTION CODE 1.0
DDB PAGE NO.

P. Parker

7/17/90 - Tuesday

subject - GTE Area Tour

Ken Premo and I toured the GTE repair area this morning with Danny Gonzales. Mr. Gonzales toured us through the various repair facilities, such as the disassembly, cleaning, inspection, electrical paint, assembly, and testing areas. Also, we toured those areas which will contain repair functions to be centralized in Bld. 329. These included the new machine shop area and the new cleaning area, both of which are being set up at this time. We were shown the various component repair areas. There are several areas which will need to be characterized for this task order which were not previously examined in detail. These will include the electronics component repair and testing, the sheetmetal repair and manufacturing areas, certain machine shop functions, and the parts painting process.

I found it interesting that the GTE areas are presently experimenting with OCM practices. Mr. Gonzales mentioned that presently they are choosing only those GTEs which are found to require ~~little~~ limited repair and/or overhaul on initial receiving inspection. (The use of the most functional or "cherry" GTEs is certainly understandable for the initial prototyping of this particular maintenance practice.) I believe that this practice would greatly benefit the GTE production process, should it prove to be a viable option. I would very much like to see the IPI team become involved in this program, although Mr. Gonzales mentioned that there were some reservations expressed about this. Apparently, an outside

1-0

name - P Parker   Date 2/17/90   pg 20
acc - GTE-A11

contractor is being brought in to study this practice in some detail, and there were some concerns that we might prove a hindrance to their operations.

I noted that the GTEs are similar to the UFCs in that there is a much larger induction rate than production ~~[illegible]~~ output. The numbers quoted were inductions of 110-120/mo., with throughput around 70. We were also told that the practice of removing the serial number from the GTE (and thereby losing accountability of parts tracking) was still occurring. When I saw the large "kitting" area in the GTE area I was reminded of the problems associated with this practice, which I have seen in other industrial processes as well. It is extremely difficult to ever gain a proper understanding of any process until you began to track the flow of parts, by serial number, through the system. This problem is currently being addressed by Mr. Gonzales, and others, with an automated tracking system now under study.

We also toured the GTE final testing facility. For reference, the set-up time for the test was given as 1.5-1.75 hours. The actual test is approx. 6-8 hours, with a 15 to 20% failure rate. Mr. Victor Fountano is in charge of the testing software support, and should prove to be a good contact point in this area.

A meeting is scheduled in the MA conference room tomorrow at 2:00 pm. This meeting will serve as an introduction of the MDMSC personnel to the GTE production and production support personnel.

1.0

ENGINEERING NOTES

EMPLOYEE C. Parker DATE 7/19/90 PAGE NO. 23
RCC GTE - ALC SUBJECT General Info

7/19/90 - Thursday

Susan Schattle has provided us with copies of the Task Order One CSR and DDB for the MATPGB and MATPSI RCCs. Mr. Vroman has printed off both model runs for these areas, and we shall familiarize ourselves with these. Danny Gonzales was unavailable for a meeting today, and I was unable to contact Ron Garcia to discuss Machine Shop functions. I will set up a meeting with Mr. Garcia at the earliest date, and attempt to speak with Mr. Gonzales tomorrow about various task questions which we have.

7/20/90 - Friday

I was unable to contact Danny Gonzales this morning. Mr. Gonzales will be TDY until 7/26/90, as he is traveling to AFLC headquarters this week. Mr. Gonzales is attempting to obtain funding for a part's tracking system for the GTE areas. I hope that he will have success in this endeavor, as such a system should prove invaluable to improving the GTE overhaul and repair processes. I also believe that systems such as this could prove extremely valuable to DMMIS functions, as I believe that information collected under such a system would serve as "feeder" reports to the DMMIS files. This opinion is based on information gained from conversations with Mr. Morris Wexler, who is a representative of the DMMIS program here on KellY AFB.

I was unable to obtain a meeting with Ron Garcia to discuss Machine Shop practices and the feasibility of flexible cell or dedicated machine technology in this area. Mr. Garcia was out on personnel leave for the latter half of the day. I will attempt to contact him on Monday. I am anxious to make our initial survey in this area, as I remember from previous visits that this is a large machining area, with a fairly significant workload.

DDB SECTION CODE 1.0 DDB PAGE NO. 34

ENGINEERING NOTES

EMPLOYEE Parker DATE 7/23/90 PAGE NO. 24

RCC GTE (general) SUBJECT Appt.

7/23/90 - Monday

I have made appointments with Ms. Guzeman and Mr. Pike for tomorrow morning. I wish to discuss manpower availability and overtime questions with Ms. Guzeman. I would like to speak with Mr. Pike about information I will need from certain GTE planners, for whom he is the manager, as well as the various engineering functions which he oversees. I would also like him to suggest a point of contact for certain information which we received with the original T.O. 15 SOW, which showed both operations descriptions and associated times, as well as the RCCs involved. This data could be potentially very valuable to us. I would also like to question him in regard to various data bases which may reside in his area, and the appropriate managers to contact in regard to these.

DDB SECTION CODE 1.0 DDB PAGE NO 35

ENGINEERING NOTES

EMPLOYEE P Parker DATE 7/24/90 PAGE NO. 25
RCC GTE (All) SUBJECT meetings

7/24/90 - Tuesday

Ken Premo and I met with Mr. Pike this morning. Also present was Juan Garza, who is the planning chief under Mr. Pike. We discussed several topics, including our mutual desire to reduce impact on the production capacity of the GTE area by reducing the amount of interviews and their length, especially in those areas previously characterized. Mr. Pike identified his office as the end user of the model once we are complete. I questioned Mr. Pike about what his expectations and needs for a simulation model would be. Basically, his concept of a useable model would be one which allowed analysis of those parts which have historically caused delays or other process problems, such as quality or functional impairment to the GTEs themselves. These parts should be given special attention, as they would most likely be on the "critical path" for the GTE process. I was pleased to hear this opinion, as it fits in nicely with our concept of higher order modeling. I feel that this should make efforts much more effective than if we were driven to performing our characterization at the lowest level of detail possible.

Mr. Harris, Mr. Premo, and myself also spoke with Ms. Guzeman this morning. Ms. Guzeman provided us with information on labor hours, including overtime, for several of the RCCs involved in the GTE task order. From this data I should be able to determine the manpower availability for the various areas we will be studying. An example sheet is included as an attachment to these notes, designated with today's date.

DDB SECTION CODE 1.0 DDB PAGE NO. 36

ENGINEERING NOTES

EMPLOYEE Parker DATE 7/25/90 PAGE NO. 26

RCC machine shop SUBJECT Initial Machine Shop Obs.

7/25/90 - Wednesday

Mr. Gardner, Mr. Vroman, Mr. Premo, and myself toured the Machine Shop this morning with Ron Garcia. Mr. Garcia discussed several points of interest with us, including machine shop workloads, layout, management, and various other related topics. We also discussed the task of analyzing the machine shop functions for applicability to flexible cell manufacturing and/or group technology. Mr. Garcia has performed some preliminary studies in this area which I feel show significant promise. He has carried out some initial analysis regarding the grouping of items by geometry, as well as by machines and process. Due to his extremely busy schedule, he has not been able to put the time and effort into this area that he would have wished. I feel that we should examine this data in detail when we begin the characterization and analysis of this question.

One important determination which will need to be made is the applicability of flexible cell technology to the the manufacturing functions of the Numerically Controlled (NC) machines found in this shop. After some discussion, I expressed the opinion that these machines would probably not be acceptable candidates for this technology. The usage of Numerically Controlled (NC) machines in ALC operations may appear quite low by industry standards, especially given the capital intensive nature of this equipment. Unfortunately, given the high variability and relatively small lots that are historically involved, it would probably be impractical to contract this work out to other sources. These same conditions would appear to make the NC machines poor candidates for consideration in any flexible cells or dedicated machine grouping.

On the other hand, the repair processes being performed in this machine shop may well prove to contain several candidates for grouping into flexible or dedicated cells. The volume of items in work is often fairly stable and well defined. The repair processes themselves are

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2

ENGINEERING NOTES

EMPLOYEE P Parker
DATE 7/25/90
PAGE NO. 27
RCC machine Shop
SUBJECT Machine shop obs:

probably fairly well defined, and machinists in this area should be well familiar with various constraints and variables associated with this workload. These considerations may indicate that logical groupings of dedicated machines could produce improvements in the candidate processes. Savings in set-up and machining time, as well as the related labor savings, could be possible. Quality might also be affected as the machining processes would be more easily managed. More efficient scheduling and planning of workloads might also be realized. While all of these points are mere conjectures at this point, I do feel that certain of the repair processes involved could be candidates for this technology.

Mr. Garcia introduced us to production, scheduling, and planning chiefs in this area. Per Mr. Sanchez (production chief) request, Mr. Garcia is setting up a meeting with essential personnel in this area so that we can brief them on our involvement in the program.

DDB SECTION CODE 1.C
DDB PAGE NO. 38

ENGINEERING NOTES

EMPLOYEE Parker DATE 7/26/90 PAGE NO. 28
RCC GTE (All) SUBJECT GTE scheduling software

7/26/90 - Thursday

Scott Vroman, Ken Premo, and myself met with Danny Gonzales to discuss various points of interest in regard to the GTE task order. Mr. Gonzales had just returned from AFLC Headquarters, where he was successful in obtaining funding for an expert system/parts tracking package for the GTE area. We were all quite pleased to hear this, as we believe that this area could greatly benefit from such a system properly implemented. I was somewhat surprised at the aggressive schedule that was set for implementing this program. The hardware is to be installed and functional by Jan. 1, 1991, and the software and configuration is to be operational in April '91. As Mr. Gonzales pointed out, this will be a rigorous schedule. I hope that we can assist him as much as possible through our efforts in this area.

The following notes represent my understanding of the system. Anyone interested in more detailed information should contact Mr. Gonzales directly. As I understand it, the system to be installed has an AT&T 3B2 system at its heart, with 40 terminals placed throughout the GTE process area. The system will support bar code and automated tracking functions, and should allow data collection throughout the process, including the parts pool. The system is to be integrated with existing data systems, and all efforts will be made to configure it in support of DMMIS functions. The desired result, in addition to a more manageable production process, would be the ability to charge the user commands for actual hours expended on specific end items. The proposal presented to the AFLC personnel included an estimated ROI of 20:1, a proposed reduction in labor by 10%, and a reduction in stock items by 10%. The software system, and the contractor to be used in configuring this system, has not yet been identified.

DDB SECTION CODE 1.0 DDB PAGE NO. 39

ENGINEERING NOTES

EMPLOYEE Parker DATE 7/26/90 PAGE NO. 29

RCC GTE (All) SUBJECT GTE general info

I mentioned to Danny that we would be interested in being of assistance in his task of implementing this system, within the constraints of this program. Mr. Gardner has offered to contact the MDMSC personnel in charge of the DOIS system, if Danny would care to be briefed on their experiences with large, interrelated tracking systems. There may be some important lessons learned in the construction and functioning of this MDMSC system, which is used to track missile production in the Harpoon Missile Depot.

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Danny also also suggested that I contact the planners for the two GTEs we are characterizing in order that we might identify the critical parts in the production processes, and how these items should best be tracked and analyzed. The planner for the 180 engine is Dan Heyward, and for the 397 engine we should contact Brent Castle (Gilbert Segura may be alternate to Mr. Castle).

DDB SECTION CODE 1.0 DDB PAGE NO. 40

ENGINEERING NOTES

EMPLOYEE Plucker DATE 7/30/90 PAGE NO. 31

RCC GTE (All) SUBJECT General Info

I made an appointment with Dan Heyward, who is the -150 GTE planner, to meet tomorrow. I would like to obtain his opinion of which parts being processed through the GTE repair operations are "critical", especially as regards high flow times. In theory, any number of other items could be processed in the time it would take for one of these "critical" items to travel through the system. Furthermore, it can be assumed that these particular items have the most detailed and rigorous repair processes, which contribute to the high flow time. If these assumptions do not prove to be true, then the actual reason for the high flowtime will need to be examined very closely.

In reference to my notes of 7/26/90, page 28, the following correction is made: The implementation of the GTE parts tracking system, and the schedule which I listed previously, is dependent on ALC funding. While the program has been granted approval, the budget to accomplish the task has not yet been completely allocated, when funds are available, the schedule is of six month duration from start to prototype implementation.

Mr. Gonzales was kind enough to assign us desks in his area, where we can centralize our GTE efforts. This is very helpful, as we now have ready access to both engineering and planning functions

We also had our second in-brief with the GTE personnel, due to the fact that attendance was low for the first meeting. Items discussed included our intention to concentrate on those items having high flow times of high costs associated with them. The only action item of this meeting was a request that we provide copies of the ALC S.O.W and our answering proposal.

DDB SECTION CODE 1.0 DDB PAGE NO. 41

ENGINEERING NOTES

EMPLOYEE PParker DATE 8/2/90 PAGE NO. 36
RCC GTE (All) SUBJECT MATPSI discussion / work sampling

I met briefly with Ed Gill this morning. Mr. Gill is a planner in MATPSI, and was instrumental in the validation of that area during T.O. one. Mr. Gill mentioned that much of the base data inputs to the MATPSI model may be applicable to our current tasks. He also expressed the opinion that the data itself was fairly representative, at least at the base level.

Mr. Gill mentioned Mr. Manuel Diego as the contact point for any questions relating to the use of the metal tags for parts tracking. Since these tags are dated with the Julian date, they may offer an opportunity for collection of historical flow times. Mr. Gill also mentioned that Roger Kiker might be a good source of information regarding the cleaning operations in MATPSI. I have some ideas regarding the use of cryogenic cleaning techniques in this area which I would like to talk to Mr. Kiker about.

After we met with Mr. Gill, Danny Gonzales, Ken Premo, and I met with personnel in MATES. These included Frank Schutter, Roger Lozano, and Yvonne Medina. As I mentioned earlier, Roger and Yvonne were responsible for a part of the Pipeline study of critical items conducted by the ALCs previously. Part of their task included the analysis of WCD historical records in order to determine flowtimes for various components (refer to page 23A). During our discussion of this effort, Mr. Schutter mentioned that he would like Ms. Medina and Mr. Lozano to become familiar with the data characterization and simulation modeling techniques which we use. I promised to deliver certain documentation relating to the program, and we agreed to work out the details of our joint efforts at a later time. This could be a significant step in our efforts to dissiminate this technology to its end user, in my opinion.

DDB SECTION CODE 1.0 DDB PAGE NO. 4.2

ENGINEERING NOTES

EMPLOYEE Phillip Parker DATE 8/3/90 PAGE NO. 37
RCC GTE (All) SUBJECT APIS historical Data

I spoke with David Christopher this morning about obtaining historical data pertaining to the Eng. Turbin Nozzle and the Turbin Bearing Housing from the -397 eng. These parts are inspected in the APIS area of MATPSI. Mr. Christopher is responsible for several aspects of the process in this area. He took the B/N numbers that Mr. Castle provided me, and said that he would have Susan Randolph compile the following data for the last four quarters:

(1) Average time in process
(2) Total items inspected
(3) Total repairable
(4) Total serviceable
(5) # condemned

I was pleased to hear that Susan Randolph is the computer programmer supporting this areas data collection system. I have found Ms. Randolph extremely helpful and knowledgeable in past efforts. The data she can provide should prove very helpful, and should be useful as both model inputs as well as validation reference material.

Based on this weeks discussion with both the planners and Denny Gonzales, I have made the followin To-Do lists. The items listed on the next two pages are meant to allow us to begin construction of the first model layer. The information to be collected will include data concerning both the critical and non-critical components undergoing repair, as well as the Accessories components for the GTE (such as fuel controls, starters, etc.).

DDB SECTION CODE 1.0 DDB PAGE NO. 43

ENGINEERING NOTES

EMPLOYEE Premo DATE 7/12/90 PAGE NO. 1/A

RCC ~~[illegible]~~ MATPGB SI SUBJECT TOUR OF GTE FACILITIES

CONTACT - DANNY GONZALES

- MR. GONZALES was kind enough to ~~[illegible]~~ give us a tour of the GTE facilities

- Engines are inducted into the facility on skids and are ~~[illegible]~~ then taken to an area where they are disassembled

  - parts are placed into baskets which are stacked awaiting cleaning at the cleaning line.

  - Mr. Gonzales says that they have identified the cleaning line as a bottleneck in the GTE area (extreme queues confirm this) - they are currently running two shifts to ~~correct~~ help throughput in the cleaning area

  - offhand, it appears as though there may still be some room for improvement in the cleaning line area. (they are currently expanding their cleaning facility)
  - other areas that were toured include:
    - inspection
    - paint
    - electrochem.
    - Assembly
    - PST
    - [illegible]

- inspection - [illegible]

DDB SECTION CODE 1.0 DDB PAGE NO. 44

ENGINEERING NOTES

EMPLOYEE Premo DATE 7/17/90 PAGE NO. 2/4

RCC ~~[illegible]~~ MAT PGB SUBJECT GTE TOUR - D. GONZAL
ST

paint - hard to set up high rates of evacuation due to the large variety of ~~[illegible]~~ objects to be painted

electrical - starter area is considered to be a "black hole" with little control ~~[illegible]~~ ~~[illegible]~~ over the flow of

machine shop - currently being ~~[illegible]~~ set up so that ~~[illegible]~~ more machining can be done "in house"

assembly - divided into different areas by engine type.

test - after ~~assembly~~ assembly engines are put on a skid and sent to test. There are 7 test stands. Each stand has ~~[illegible]~~ its own computer. The computer carries the test from start to finish. Any failures are automatically recorded to a data. The software works well but, a test can ~~[illegible]~~ not be started from a midpoint. { Set up time . apx [illegible] / test time . apx [illegible] }

- Apx 15% of engines fail test

- at this moment test stands are not completely utilized (apx 50% utilization)

- Some of engines into the test area [illegible] separated and [illegible] to [illegible] at the end of a month [illegible]

ENGINEERING NOTES

EMPLOYEE Pearce DATE 7/17/96 PAGE NO. 3/4
RCC MATPGA /SI SUBJECT GTE TOUR, D. GONZALES

- at this moment, apx 70 engines are completed per month, but over 100 are inducted into the system every month

- excess inventories of parts are building up in the parts area and these account for the difference between inductions and output

- parts are stored as "kits". In theory these kits are supposed to remain together, but in reality they are robbed from to get good parts...

- currently there is no tracing of parts by serial number - once an engine is dissassembled the parts for a given engine are mixed with others.

- if an engine fails the testing phase and can't be repaired it is sent back to the beginning of the GTE repair process and is completely overhauled again

  - this seems to be a great duplication of effort and is wasteful

  - also, because parts serial #'s are not tracked it is possible for a bad part [illegible] to (which might still be out of inspection) to continuously spread through the parts supply and cause several engine failures

    - this [illegible] [illegible] problem [illegible]

DDB SECTION CODE 1.1 DDB PAGE NO. 46

ENGINEERING NOTES

EMPLOYEE Premo DATE 7/17/90 PAGE NO. 4/4
RCC MATPENT /SI SUBJECT GTE TOUR, D. GONZALEZ

be cured by 2 possible methods:

1) improved inspection methods for parts
2) serial # parts tracking

- Cure # 1 depends upon the identification of a problem part ~~which~~ or [illegible] inspection process. However, the [illegible] current ~~p~~ repair procedures don't appear to be set up to locate ~~for~~ defective parts once they pass inspection.

- the second cure (#2) would help to identify parts that for some reason keep showing up in the failing engines. [illegible] A part serial # tracking would help to locate parts that have "learned" to pass inspection and would be very useful for ~~in~~ process characterization.

DDB SECTION CODE 1.C DDB PAGE NO. 47

ENGINEERING NOTES

EMPLOYEE Premo DATE 6/29/90 PAGE NO. 3

RCC ____ SUBJECT GTE meeting

initial meeting GTE

10 years ago - poor quality, [illegible] the current overhaul policy

⇒ Now want to move to RCM because of high overhaul cost and customer complaints

⇒ would like [illegible] for [illegible] RCM [illegible]

[illegible] KIKER - [illegible] [illegible] in GTE [illegible]

Danny Gonzalez - contact in GTE [illegible] getting [illegible]

- virtually all engines are completely overhauled, whether they need it or not
- this is very wasteful and [illegible]
  - need a better method for diagnosing problems?
  - [illegible]

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ENGINEERING NOTES

EMPLOYEE P. Parker DATE 8/22/90 PAGE NO. 60

RCC GTE all SUBJECT Engr. assessment

A meeting was held with Irene Brown today. The following personnel attended:

Irene Brown	AFLC
Susan Schottle	SA-ALC
Danny [illegible]	SA-ALC
Greg Gardner	MDMSC
Ken [illegible]	MDMSC
Philip Parker	MDMSC

We discussed the overall approach to the GTE Task Order effort. We discussed the concept of work sampling, the use of stamped WCAs for reference [illegible] ([illegible] return ALCs), the layered modeling approach, and other issues. Ms. Brown felt that we were on the right track as far as modelling was concerned, and conversation turned to engineering assessment.

I promised Susan Schottle that I would not use these notes as a forum for discussion of project issues, but would restrict myself to specific Task Order issues. [illegible] to be [illegible] [illegible] this, because here I go again.

It is very difficult to perform a meaningful [illegible] assessment of an area such as the GTE project [illegible]. [illegible] This is true in many of the ALC production processes. I have [illegible] identify meaningful areas of improvement, [illegible] constraints of the ALCs [illegible] budget [illegible] system. [illegible] support functions [illegible] and production management [illegible].

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ENGINEERING NOTES

EMPLOYEE C Parker DATE 8/22/90 PAGE NO. 51

RCC GTE 611) SUBJECT Engr. assessment

functions (often at the expense of true process improvement potential).

Possibly much of this problem has to do with what we, MDMSC, are considering to be engineering assessments. We tend to concentrate on very specific problems, often at the expense of more global or underlying causes. Consequently, we often end up satisfying no one, including ourselves. For this reason I have lately questioned these practices, and perhaps because of my particular engineering specialty, have begun to believe that what is really needed in the ALC environment is a detailed, wide scope Industrial Engineering assessment. When the "as-is" condition of many ALC processes are examined, this case, it appears justified. Process problems are not systematically defined, documented, or examined in a controlled, logical manner in many cases. Process accountability is often haphazard, or artificial in [illegible] structure. Solutions to problems are too often of a "quick fix" nature, perhaps due to the shortage of ALC engineering support staff, with the main emphasis on short term solution to meet immediate production needs. It seems to me that what is really needed is the application of solid, time-tested Industrial Engineering practices and techniques; such as well engineered labor standards, appraisal systems tied into actual productivity, well defined production accountability, detailed and precise historical documentation of production processes, and a defined and structured approach to solving individual process problems (such as the use of SPC and Taguchi methodology, the use of Quality assurance and reliability techniques, implementation of feedback criteria and structure, viewing production from a systems viewpoint, etc.). This seems so obvious to me, as does the fact that [illegible] [illegible] production [illegible] the [illegible] productive function we could have, that I felt obligated to share it at this meeting. Since [illegible] expressed my [illegible] [illegible] was a revelation of any sort [illegible], I suppose

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ENGINEERING NOTES

EMPLOYEE P. Parker DATE 8/22/00 PAGE NO. 2

RCC GTE (all) SUBJECT Engr. assessment

that I.E. techniques do not thrill the soul as do clever new designs or short term solutions to specific problems. Still, I feel that we should remember that even if we solve these specific problems in an ALC process, if we become "heros" from our efforts, we do not really effect significant change if certain substandard ALC practices do not change. These "bad habits" often time outlive a particular workload, as they are people problems, and are passed from one generation of production personnel to the next. The only cause for hope is that each group teaches the next how to work "around" the flaws in the system, which can have its own obvious drawbacks.

In any case, the specific areas which we are examining as potential improvement areas for GTE processes include providing a structured approach to solving, or at least characterizing, the apparently serious vibration problems in GTEs, which appears to be responsible for nearly 50% of [illegible] rejects of the unit during final test. We are also examining those areas where unnecessary delays or material handling problems between RCCs could be reduced on critical high flow time items. We have high hopes that the work sampling will be of help here. We are also looking into the use of cold jet applications for certain cleaning functions that are now being used in the GTE area, as well as those to be implemented [illegible] MTSI in the near future. We will provide weekly updates of these from now on, as well as any other areas of potential improvement we find.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-1-90 PAGE NO. 1/9

RCC ______ SUBJECT GTE - meeting with Danny Gonzales and Brent Castle

During our meeting Mr. Castle mentioned three major components for the GTE that ~~are~~ have a considerable amount of flow time in the GTE overhaul ~~of~~ process. The comonents we discussed are:

1. Engine turbine nozzle - this part has some delay times in backshop areas due to batch size requirements for some of the processes
2. Second stage Diffuser assembly (short stack) This part has extensive machining time in it's repair process.
3. Turbine bearing housing - changing the bearings causes some scoring of the housing and requires some replating or repair

A more detailed flow of the work on these three components follows.

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ENGINEERING NOTES

EMPLOYEE Premo
DATE 8-1-90
PAGE NO. 2/9
RCC
SUBJECT GTE (-397) Brent Castle

ENGINE TURBINE NOZZLE

Mr. Castle believes that this component is a "critical" component in the GTE repair process because of the large amount of unavoidable ~~downtime~~ delay time in ~~the~~ some of the backshops. The ~~primary~~ operation that consumes the most flow time is the flouride ion cleaning process. Because of ~~ex~~ environmental impacts only full batches are run in the cleaning chamber. Fifteen of the nozzles consitutes a full batch in the cleaning process. A limiting factor in the quantity of parts that can be done at one time is the amount of weight that the chamber racks can ~~so~~ support without permanent deformation. Other parts may be treated in the chamber with the nozzles ~~in~~ so that a "full load" can be made up of a mix of parts. At this point it is unclear as to the exact amount and mix of ~~parts~~ different parts that could be used to make up a full batch. F100 compressor retainer rings, F15 starters, and small turbine stators are also ~~treated in the f~~ cleaned using the flouride ion process. The process takes about 18 hours per batch. Once parts are cleaned they cannot be touched by human hands until they are finished with the next process in the operation (nickel braze).

About 70% of the incoming nozzles require extensive rework (including flouride ion cleaning) About 20% need only minor work, and the remaining 10% require a moderate amount of work. On the next page a flow of the extensive rework process in outlined.

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ENGINEERING NOTES

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RCC

SUBJECT GTC (-329) B. Castle

disassembly

↓

360 — cleaning (three procedures)

↓

— NDI, mandatory flourescent penetrant inspection

↓

— Visual inspection, 31 steps, non-dimensional,
27 vanes are inspected

↓

↓ 70% need extensive rework

301 — chemical strip

↓

301 — vapor degrease

↓

303 — preliminary vane rework

↓

339 — Flouride ion cleaning (18hrs)

↓

324 — nickel braze area

↓

324 — vaccuum furnace (9hrs)

↓

324 — post furnace braze inspection

↓

303 — final machine and grind to remove burrs and
roughness etc.

↓

303 — FPI

↓

329 - parts pool

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ENGINEERING NOTES

EMPLOYEE Premo
DATE 8-1-90 PAGE NO. 4/9
RCC
SUBJECT GTE (-377), Brent Castle

SECOND STAGE DIFFUSER ASSEMBLY

This assembly is made up of three major components:

1) de-swirler
2) diffuser
3) housing ("dishpan")

Together they are often called the "short stack"

The repair process as it is now consumes a very large amount of time and resources ~~because of the way~~. The primary reason the assembly is taken apart is to repair and inspect the vanes of the diffuser. However, this set of operations makes up only a small portion of the repair process for the short stack assembly. A large amount of time is spent on rework and machining that is required to remate the parts for final assembly. Because, the ~~dish~~ housing and diffuser are essentially a "custom mated" assembly, ~~they~~ they are not ~~interchan~~ interchangable individually with parts from other matings. ~~Unfortunately,~~ ~~If~~ ~~In order to avoid a large amount of machin~~ It is not possible to assemble previously unmated parts without extensive machining of the diffuser and dishpan. This is done by blanking out holes and hubs and then remachining the parts ~~together~~ to match ~~[illegible]~~. This requires a tremendous amount of time in welding, stress relieving, and machining

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ENGINEERING NOTES

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RCC ______ SUBJECT GTE (-397) Brent Castle

All of this extra work could be avoided by keeping the diffuser and dishpan together (as a matched set) through the repair process. Currently, this problem is in the process of being corrected by plans to dedicate a machining cell in 324 to the short stack process. By keeping the short stack components "in house" it will be easier to keep them together as matched sets. This sounds like an excellent idea.

Following is a more detailed description of the repair process for the "short stack".

360 – prior to disassembly, the parts are cleaned as a uni
↓
329 – post cleaning (parts are still together) (detailed)
↓
329 – disassembly into seperate parts
↓
329 – NDI, at this point in the process they start to batch parts and the parts may get seperated from their siblings.
↓
329 – Inspection: the diffuser and housing get visual and dimensional inspection and the deswirler gets visual inspection only
↓
329 – At this point the parts are seperated and follow different paths.

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ENGINEERING NOTES

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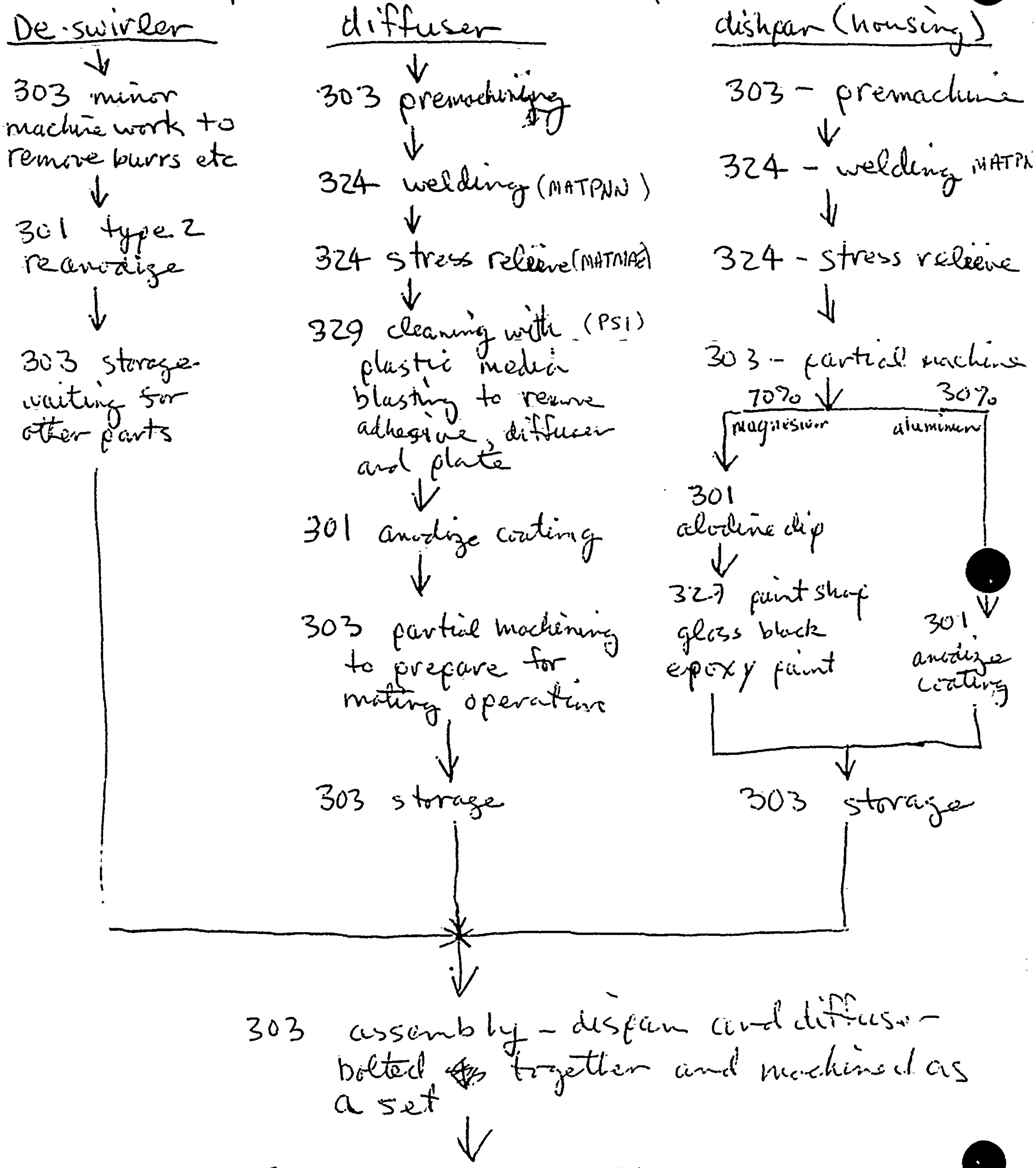
RCC

SUBJECT GTE(-397) Brent Castle

FLOW AFTER INSPECTION



De-swirler
↓
303 minor machine work to remove burrs etc
↓
301 type 2 reanodize
↓
303 storage waiting for other parts

diffuser
↓
303 premachining
↓
324 welding (MATPNN)
↓
324 stress relieve (MATMAE)
↓
329 cleaning with (PSI) plastic media blasting to remove adhesive, diffuser and plate
↓
301 anodize coating
↓
303 partial machining to prepare for mating operation
↓
303 storage

dishpan (housing)
↓
303 - premachine
↓
324 - welding MATPN
↓
324 - stress relieve
↓
303 - partial machine
70% magnesium
↓
301 alodine dip
↓
327 paint shop gloss black epoxy paint
30% aluminum
↓
301 anodize coating
↓
303 storage

↓
303 assembly - dispan and diffuser - bolted together and machined as a set
↓

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ENGINEERING NOTES

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RCC

SUBJECT GTE (-329) B. Castle

↓

303 Flourescent penetrant inspection

↓

303 machine shop area, parts opened up for cleaning and deburring

↓

303 all three components bolted together into a frame assembly.

↓

329 completed parts are sent to the compresser sub-assembly area.

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ENGINEERING NOTES

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RCC ______ SUBJECT GTE (-329) B. Castle

Turbine bearing housing 373237 -200 -250

This component is made of steel and can be in a corroded state when it is received for rework. The major goal of the repair process is to replace two bearings; one on each end of the housing. The bearings must be pressed out of the housing and this process may score the bearing ~~races~~ seats. After the bearings are removed the housing is inpected and the bearing ~~races are~~ seats are checked dimensionally. If a ~~[illegible]~~ seat ~~id~~ ID is to large the unit is sent to be built up. Depending upon whether or not the housing has been previously reworked or not ~~the~~ it can take different paths at this point. Following is a mor detailed description of the flow for the turbine bearing housing.

Bearings are pressed out

↓

360 - vigorous cleaning

↓

329 - cleaning and corrosion treat (oil bath)

↓

329 - mandatory FPI

↓

329 - visual and dimensional inspection

↓

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ENGINEERING NOTES

EMPLOYEE Premo
DATE 8-1-90
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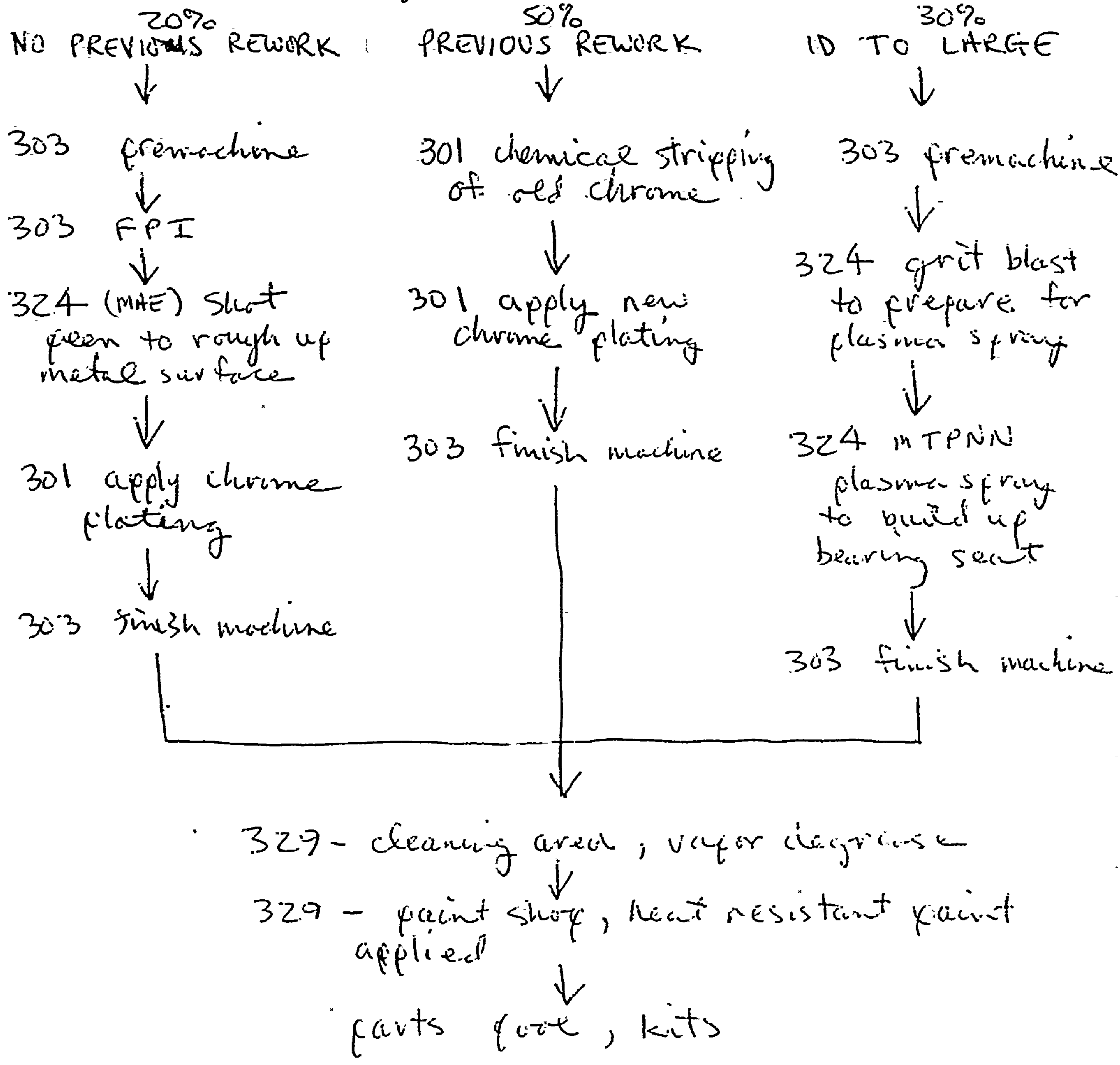
RCC
SUBJECT GTE (-329) B. Castle

Depending upon if the housing has been previously reworked and upon the bearing seat ID the housing can follow different paths:



20%
NO PREVIOUS REWORK
303 premachine
303 FPI
324 (MAE) Shot peen to rough up metal surface
301 apply chrome plating
303 finish machine
50%
PREVIOUS REWORK
301 chemical stripping of old chrome
301 apply new chrome plating
303 finish machine
30%
ID TO LARGE
303 premachine
324 grit blast to prepare for plasma spray
324 MTPNN plasma spray to build up bearing seat
303 finish machine
329 - cleaning area, vapor degrease
329 - paint shop, heat resistant paint applied
parts post, kits

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-2-90 PAGE NO. 1

RCC ________ SUBJECT Meeting with Ed Gillas

In our meeting we possible methods of gather data ~~[illegible]~~ ~~[illegible]~~ for the GTE repair process.

Mr. Gillas feels that the use of laser tags with julian dates would be very usefull in gathering flow time info. Specialized tags could be generated specifically for this tracking. This method would likely be most effective in areas when tags are currently in use. In areas where tags are not now being used, parts ~~[illegible]~~ with tags might get special treatment and carrupt the flow time data.

Some contacts:

Manuel Diegos - an engineer who could help with tagging and tracking of GTE parts

Susan Randolph - machine shop - help with tags

Roger Kiker - cleaning line

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-7-90 PAGE NO. 1/3

RCC MATPMC SUBJECT OIL COOLER GTE -397 -180

Oil coolers for the -397 and -180 GTE's are worked in RCC MATPMC in building 329. A foreman in the area, Mr Berlyn Wade, refered me to ~~a~~ David Urdiales who is a mechanic in charge of working the oil coolers. Following is a summary of our conversation on 8-7-90:

~~Part~~s ~~a~~

The coolers arrive through normal routing channels in ~~2~~ groups of about 12 units. Mr. Urdiales is usually the only person to work the oil coolers for the 397 and 180 GTE's. After ~~t~~ arrival, the parts usually don't sit for long until ~~they~~ Mr. Urdiales begins work on them. All ~~parts~~ coolers are processed in the same manner. The coolers are first stripped down and flushed. Next they are pressure tested to 100 psi. Any leaking tubes are replaced and any leaks in the shell are welded. The cooler is then flushed, pressure tested, cleaned, corrosion treated, painted, and finally returned to the parts pool. Usually, ~~some~~ someone comes by once a day to pick up any finished oil coolers and take them to the parts pool. The time required to repair an oil cooler is directly dependent upon the number of tubes that are faulty. There are a total of 262 tubes in the core. The tubes are made of very thin aluminum and corrosion often causes leaks. This is especially true for the older coolers. According to Mr. Urdiales, the lifespan for a cooler is about 10 years. Some of

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ENGINEERING NOTES

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RCC MATPMC SUBJECT OIL COOLER GTE -397 -180

the older coolers have so much corrosion to several of the tubes that it takes a very large amount of time to repair them. About 25% of the oil coolers that come in are so bad that they are not worked. Mr Urdiales feels that it would take more time to replace the tubes ~~that~~ in these cooler than is economical using current repair proceedures. At this time a new cooler sells for about $700. I might take several days to repair a cooler that has a large ~~amo~~ number of tubes that are in need of replacement. The minimum time to repair an oil cooler was estimated by Mr. Urdiales to be about 3.0 hrs. The average oil cooler takes about 4.0 hrs. The longest it takes to repair one is 8.0 hrs, ~~but~~ but it should be noted that this figure doesn't include the 25% of the coolers that are shelved due to excess leaks. Mr. Urdiales produces about 3-6 coolers per day.

Mr. Urdiales suggested a change in repair technique for those coolers that have a large number of leaking and corroded tubes. Rather than replacing each of the individual tubes that leak, he suggested that the entire core of tubes be replaced. He thought that this would actually take less time than current procedures.

The only equipment constraint in the repair process is the flushing stand. The stand is very old and leaks. There is only ~~[illegible]~~ one flushing stand. Three coolers

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-7-90 PAGE NO. 3/3

RCC ______ SUBJECT ______

can be flushed at one time and
the flushing process takes about 2 hrs.
There are 8 mechanics working in the area where
oil coolers are worked. The oil
coolers for the -397 and -180 GTE's make up
about 10-15% of the workload and utilize
about 10-15% of the manpower. There
is only one shift (1st shift).

OPINION AND OBSERVATIONS

Mr. Urdiales idea to replace the entire core
of those oil coolers with an excessive number
of leaking tubes deserves further
consideration. It may be a good idea
even if time is not saved in the
process. Because the major amount of
repair work for the coolers is the replacement
of corroded tubes, replacing the entire
core with new tube's would effectively
extend the lifespan of the cooler to almost
that of a new one. A considerable amount
of time might be saved down the road and
future field failures would be
reduced.

The flushing stand is not causing
a bottle neck but it appears to be a
weak link in the oil cooler repair process.
Considering its age and condition it could
possibly cause some problems in the
future.

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ENGINEERING NOTES

EMPLOYEE Ken Premo
DATE 8-7-90
PAGE NO. 1/4
RCC MATPPA
SUBJECT FUEL CONTROL - BACKSHOP INTERVIEW WITH CHARLES KNAPE

FUEL CONTROLS for the -180 and -397 GTES are worked by RCC MATPPA in building 323- Charles Knape (5-3559) is the current supervisor in charge of the fuel control repairs. ~~Following~~ Following ~~are~~ is a summary of our conversation on 8-7-90:

Parts are received through normal routing. The controls are initially inspected. About 10% are in obvious need of a complete overhaul. ~~and are~~ These units are sent to be disassemble without further testing. The remaining 90% of the fuel controls are prepared for OCM by replacing a few seals and o-rings. Next, the controls are placed on a test stand ~~for~~ in order to determine the needed repairs. Of the 90% of controls that go to OCM, about 60% need minor rework and/or adjustments. The remaining 40% need a complete overhaul. After overhaul the controls undergo a final acceptance test. The test stand is in another building and hense parts must be shuttled back and forth between buildings. This takes some additional time and increases flow time. Mr. Knape gave some rough approximations of the touch time required to work the controls. All times given were for average touch ~~Shown times~~ time plus or minus about 1/2 hour. The times also include delays during the repair process. A complete overhaul without first going to OCM (10% of the parts) takes about 7 hrs. If a control is sent to OCM and it turns out that it needs an

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ENGINEERING NOTES

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RCC MATPPA SUBJECT FUEL CONTROLS GTE -180 -397

overhaul, the process takes longer at about 9.5 hours. This is about 2½ hours longer that the straight overhaul without OCM. If a part goes to OCM and then only requires minor repair or adjustments ~~[illegible]~~ time is reduced to about 4.5 hrs. Despite the additional time that is required for those controls which must undergo ~~[illegible]~~ both OCM and overhaul, Mr. Knape feels that time is saved using the OCM concept. A weighted average of his rough estimates of times yields ~~[illegible]~~ an average time of about 6.5 hrs per unit. This is slightly less than the average time for an overhaul without OCM (7 hrs). In addition, there is some savings on parts for those controls which only need minor repairs and/or adjustments. According to Mr. Knape, the condemnation rate for the fuel controls is low because ~~[illegible]~~ most of the parts can be replaced if needed. However, parts shortages are the ~~most~~ major cause of delays in the repair process. There are no major equipment constraints other than the location of the test stand in another building which causes some delays due to transportation. Overall, Mr Knape estimated (rough) the total dwell time for a part from induction to sell off to average about 2 days.

Manpower for the fuel control area is 16 mechanics and and 6 testers. All work 1st shift except one tester who works a second shift in order to promote continuity in the testing process. ~~Also~~ Mr Knape

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ENGINEERING NOTES

EMPLOYEE Premo
RCC MIATPPA
DATE 8-7-90
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SUBJECT FUEL CONTROLS GTE -180/-397

estimates that fuel controls for the -180 and -397 GTE's represent about 15-20% of his workload and occupy about 3/22 or 14% of his manpower.

Mr. Knape's area serves 2 customers: engines and supply. Of the two, engines is considered the most important and takes priority. Work is scheduled based upon the many competing factions requiring parts. There is a work schedule supplied to Mr Knape from the parts pool and he attempts to meet it the best he can on a pro-rata basis. The schedule is based on quarterly delivery requirements. As with many of the other backshops there is a constant juggling of workload to meet scheduling. It is possible to be behind on the schedule and not cause production delays. In order to avoid trouble Knape makes sure that he delivers enough fuel controls to stay ahead of engine production. To accomplish this he keeps a schedule of engine deliveries and uses it to prioritize his workload.

OPINION AND OBSERVATIONS

The use of the OCM concept appears to be saving some time. However, the savings in time seems minimal (½ hr). I would think that the savings should be larger. It could be that the high number of controls that do need overhauling (46%) minimizes the time savings that can be realized. The location of the test stand

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RCC MATPPA
SUBJECT FUEL CONTROLS GTE 180/397

in anouther building contributes to the loss in time savings. Relocation of the stand might help ~~this~~ ~~reduce~~ to increase the OCM time savings. ~~How~~ However, I suspect that the greatest savings of the OCM concept is related to the parts supply problem. A considerable amount of time and money is probably ~~saving~~ saved in ~~those~~ the 54% of controls that don't require an overhaul and hense don't require as many parts. Overall, I think the OCM concept is saving time and money. Something needs to be done with the parts supply system in order to reduce production delays due to the parts ~~problem~~ supply problems.

Scheduling is also an area that could use some improvement. The schedules that are supplied by the parts pools ~~are often~~ might be unrealistic. The schedule is almost impossible to follow because Mr. Knape is constantly "putting out fires" in an attempt to juggle the production requirements of his many customers. I reality, he follows ~~production~~ the engine production schedule; not the schedule given to him by the parts pool. Perhaps a more realistic production schedule based upon actual engine production ~~could~~ and predicted engine delivery ~~is in~~ would help.

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ENGINEERING NOTES

EMPLOYEE Premo
DATE 8-8-90
PAGE NO. 1/2
RCC MATPPH
SUBJECT LOAD VALVES, GTE $^{-180}_{-397}$

Load valves are overhauled in RCC MATPPH, building 333. On 8-8-90 I interviewed an alternate supervisor in the area, Tony Moon. Two work leaders, Mark Ramirez and Robert Fernandez, were also involved in the conversation. Following is a summary of ~~out~~ our conversation:

Parts are routed to bld 333 using normal routing channels. 100% of the load valves undergo an overhaul process. The overhaul process consists of cleaning, disassembly, inspection, backshop machining and plating, reassembly, and test. Touch time for the process (excluding backshops) averages about 8.5 hrs with a minimum of 7.5 hrs and a maximum of about 9.5 hrs. With the time in backshops included, the average ~~time~~ flo[illegible]m for the process is about 3-4 days, with a minimum of about 1.5 days and a maximum of about 6 days. The major bottleneck in the process is machine shop work if it is required. If the bore of the load valve is damaged it must be sent to the machine shop 2 different times. Bore rework requires first sending the valve to ~~machine~~ the machine shop to rough machine it to prepare it for plating. The valve is then ~~sent to~~ routed to plating and the bore is plated. The valve is routed to the machine shop a second time to ~~grind the~~ final grind the bore plating. This final grind is the most time consuming of the operations because the machine shop ~~a~~ works them in lots of about 20-40. There are no equipment contraints for the process other those those

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ENGINEERING NOTES

EMPLOYEE Premo

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RCC MAT PPH

SUBJECT LOAD VALVE GTE -180 -377

in the machining and plating backshops. There are some delays caused by parts shortages. Work is scheduled on a demand basis. There is a quarterly schedule that the shop attempts to meet on a pro rata basis. However, primary emphasis is placed upon meeting the immediate requirements for the GTE deliveries.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-8-90 PAGE NO. 1/2
RCC MA TPPH SUBJECT CENTRIFUGAL SWITCH GTE

Centrifugal switches are overhauled in RCC MATPPH in building 333. Pamela Pons is the current supervisor in charge of the process. Following is a summary of our conversation on 8-8-90:

Ms. Pons' area serves 3 customers: GTE's engines, and supply. Parts are received through normal routing channels. 100% of the parts that are inducted go through the same overhaul process. Overhaul of the centrifugal switches involves disassembly, cleaning, inspection, reassembly, and finally testing. Total time invested in the overhaul process ranges from a minimum of 4 hrs to a maximum of 5 hrs, with an average of 4.5 hrs. After the parts are reassembled, they are tested in lots. About 10% of the switches are condemned due to excessive wear in the bore. Of the 17 mechanics in Ms. Pons' area, she estimates that one third are used in repairing centrifugal switches. There are no equipment constraints in the switch overhaul process. According to Ms. Pons, parts shortages are her major problem. At the time of our interview, there was a work stoppage in the switch overhauls due to a shortage of bearings. There are no substitutes for the bearings and ~~the~~ production of centrifugal switches is behind by 45 units due to the shortage. Ms. Pons is constantly juggling her workload in order to satisfy the three customers she serves. ~~Often~~ It is possible to be behind on a schedule

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RCC MATPPH SUBJECT CENTRIFUGAL SWITCH, GTE -180 -397

from the parts pool (on a pro-rata basis) and still be ahead of GTE production. ~~GTE~~ Like others in the backshops, Ms. Pons keeps an eye on a schedule of ~~engine~~ GTE delivery dates and makes sure ~~to~~ she keeps ahead of it.

OPINION AND OBSERVATIONS

The centrifugal switch overhaul process doesn't appear to be on the critical path in the GTE repair process. However, problems with the parts supply could cause ~~first~~ some major delays if there is a long term ~~shortage~~ part shortage at an inopertune time. A more realistic scheduling system based on GTE ~~on~~ ~~engine~~ deliveries might help to eliminate some of the schedule juggling that goes on in many of the backshops.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-8-90 PAGE NO. 1

RCC MATPPH SUBJECT AIR PRESSURE REGULATOR GTE [illegible]80 [illegible]97,

Air pressure regulators for -180 and -397 GTE's are repaired in RCC MATPPH in building 333. Pamela Pons is the supervisor in charge of the process. Following is a summary of our conversation on 8-8-90:

The repair process for the regulators is fairly simple and straight forward. The parts are received through normal routing channels. The regulators are disassembled, cleaned, inspected, reassembled, and tested. ~~All parts are go through~~ All regulators go through the same process. Average time for the process is 1.5 hours, with a minimum time of 1.0 hr. and a maximum of 2.0 hrs. About 20% of the air pressure regulators that are inducted are condemned due to ~~warpage~~ warpage and/or corrosion. Ms. Pons has a total of 17 mechanics in her area and estimates that 33% are utilized working the regulators. There are no equipment contraints in the process. The major ~~problem~~ problem in the repair process is a parts shortage. According to Ms. Pons there is sometimes a 2-3 day delay awaiting repair parts.

OPINION

This area doesn't appear to be a bottleneck for the GTE repair process. Ms. Pons' estimation of % manpower utilized appears to be too high.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-9-90 PAGE NO. 1/2

RCC MATPPH SUBJECT OIL PUMP GTE -180, -397

Oil pumps for the -180 and -397 GTEs are overhauled in MATPPH, building 333. Joe Trinidad is a supervisor involved with the process. Following is a summary of our conversation on 8-9-90:

The pumps are routed to MATPPH from disassembly. All pumps are overhauled (100%) in the same manner. Overhaul consists of: disassembly, cleaning, component testing, visual inspection, repair and/or replacement of parts, reassembly, test, and final inspection. Average time for each overhaul ranges from a minimum of 5 hrs to a maximum of 8 hrs, with most ~~parts~~ pumps taking about 6 hrs each. There are 16 mechanics working in Mr. Trinidad's area and there is only one shift at the present time. Oil pumps for the -180 and -397 GTEs make up about 10-15% of his present workload and occupy about 25% of his mechanics. The condemnation rate for the oil pumps is very low because any bad parts are replaced ~~by~~ with new ones. Present policy is that more than 75% of a pump's parts must be defective before it is condemned. This seldom happens. There are no significant equipment constraints according to Mr. Trinidad. There is only one test stand but this doesn't cause ~~and~~ any problems unless there is a breakdown. However, ~~Thes~~ ~~bre~~ test stand breakdowns are rare. The major production slow ups are caused by a shortage of parts from supply. Mr. Trinidad bases his production upon the schedule of GTE delivery dates. He ~~also~~ couldn't ~~to~~ give a ~~good~~ estimate of the dwell times before and after ~~a~~ overhaul.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-9-90 PAGE NO. 2/2
RCC MAT PPH SUBJECT OIL PUMP, GTE -180, -397

OPINION AND OBSERVATIONS

Mr. Trindad has basically the same problems as the other backshops that are involved in the GTE ~~repair~~ repair process. Shortage of parts is his #1 problem. Also, ~~he~~ like the other backshops, he bases his production on the GTE delivery schedule, not the parts pool schedule.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-9-90 PAGE NO. 1/2

RCC MATPMM SUBJECT ELECTRIC KIT, BASKET 2, GTE -180 -397

The electric kit is worked in RCC MATPMM in building 329. Jose Jinenaz is a foreman involved with the repair process in that area. Mr. Jinenaz, ~~and~~ Richard Ozuna, and I discussed the repair process on 8-9-90. Following is a summary of our conversation:

The electric kit consists of the wiring harness, oil pressure switches, thermocouples, and ~~other~~ misc electrical components on the GTE. Kits for the 180 and 397 GTEs differ in that ~~the 397~~ some of the components are consolidated ~~on~~ into a sheet metal box on the 397 GTE. Although ~~slightly~~ they are slightly different in form, all kits are worked basically the same way. The components are disassembled, cleaned, inspected, tested, and reassembled. Some parts that ~~fa~~ fail inspection or testing are discarded and replaced with new parts. If possible parts like the harness and the sheet metal box (397) are repaired, provided the damage isn't too extensive. About 50% of the wiring harnesses and 40% of the sheetmetal boxes (397) are in need of such extensive repairs that they are condemned. Sheet metal boxes that are in need of repair are sent to the sheet metal shop. Of all the components in the electric kit the control box causes the most delays. ~~Depending upon the degree of repair that is~~ The flow time for work an electric kit depends upon the extent of repairs that are

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ENGINEERING NOTES

EMPLOYEE Preno DATE 8-9-90 PAGE NO. 2/2

RCC MAT PMM SUBJECT ELECTRIC KIT GTE -180 -397

needed. The minimum time to work a kit is about 5 hrs. The average time is around 8 hrs. The longest time is about 16 hrs and involves extensive repair to the wiring harness and electrical control box, There are no equipment constraints ~~and there are no in fo~~ for the process and there is no major problem with getting parts. There are 12 mechanics in Mr. Jimenez's area. The electric kits for the -180 and -397 GTE's make up about 10% of the workload in that area and occupy about 17% of the manpower.

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ENGINEERING NOTES

EMPLOYEE Bruno DATE 8-10-90 PAGE NO. 1

RCC MAT PDR SUBJECT TACH GENERATOR ATE [illegible]

Talked to supervisor in avionics building 315, Humberto Valdez. Mr Valdez's department receives the tach generators through ordinary routing channels. Normally the tachs arrive in small quantities and they are allowed to collect until a lot of about 50 builds up. At this point, the parts are worked. The process is relatively simple and straightforward. The tach generators are cleaned, inspected for defects, tested, and then either sold or red tagged depending upon the results of the acceptance test. The test consists of mounting the tach on a test box and then checking the voltage output at two calibrated RPM levels. If the voltage at both test points is within a range specified by the T.O. the tach passes and can be "sold." If voltage is out of limits the tach is red tagged and condemned. Mr Valdez says that it takes [illegible] about 3 days to do 50 tach generators. This is about 1 hr per tach and this is very close to the standards set by planning (i.e. [illegible] 1.1 hr). The lot size of 50 is arbitrary, set by Mr. Valdez. Smaller lot sizes are worked if Parts is short of tach generators. In this case parts calls Mr Valdez and he immediately puts someone to work on whatever tachs they have [illegible] [illegible] when they are done working the lot [illegible] from [illegible] to [illegible] parts [illegible] (spare parts) [illegible] [illegible] the normal routing [illegible] [illegible] [illegible] Silver [illegible]

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ENGINEERING NOTES

EMPLOYEE Prema DATE 8-10-90 PAGE NO. 2

RCC MATPBA SUBJECT

complained that the parts were "getting lost" on the return trip

100% of the tach generators are put through the above mentioned process. Roughly 10% of these ~~[illegible]~~ are not within specifications and are red tagged and sent to building 327. Mr. Valdez believes they are then scrapped.

OPINION: - I'm not sure why the tach generators have to be ~~[illegible]~~ cleaned and tested over in the avionics section of building 375 (MATBA). The test seems simple and straight forward and could be done elsewhere. Flow time might be reduced by keeping the tachs "in house" in build 327 and thus reducing transfer times ~~[illegible]~~, ~~the~~ between RCC's. However, if it turns out that ~~the~~ sending the tachs to avionic isn't ~~[illegible]~~ causing any problems and delays in the GTC process, any change in the current system may not be ~~[illegible]~~ ~~[illegible]~~ needed or justified.

- At the present time there are no equipment constraints. However, a test box failure might cause some assembly line delays ~~[illegible]~~ if the current large lot sizes are used.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 8-10-90 PAGE NO. 1/2

RCC MAT PMC SUBJECT ELECTRIC STARTER GTC -180/-377

Electric starters for the -180 and -377 GTC's are overhauled in RCC MAT PMC in building 327. Berlyn Wade is the foreman in charge of the overhaul process. Following is a summary of our conversation on 8-10-90:

Parts are inducted through normal routing channels. 100% of the starters are overhauled. Overhaul consists of disassembly, cleaning, inspection, reassembly, and testing. Starters arrive every 2 or 3 days in lots of about 10. Finished parts are picked up on a daily basis and are taken to the parts pool. The condemnation rate for the starters is very low because replacement parts can be used to replace bad ones. The average time to rebuild ~~the~~ a starter is apx 6 hrs. The minimum time is 5 hrs and the maximum time can be as much as 8 hrs. There are no equipment constraints in the overhaul process. The major problem in the process is obtaining replacement armatures for the starters. Some armatures are so badly damaged that the cannot be repaired. However, there is a shortage of armatures and this causes delays in the overhaul. Because of the armature shortage, only those starters with a workable armatures are chosen for overhaul. Starters with bad armatures are shelved and not worked. Despite the problems with obtaining new replacement armatures, Mr. Wade believes that it is cheaper to build up a starter with all new parts than it is to buy a complete

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ENGINEERING NOTES

EMPLOYEE Promo DATE 8-10-90 PAGE NO. 2/2

RCC MATPMC SUBJECT ELECTRIC STARTER GTE

new starter.

Mr Wade's area serves two customers; GTEs and supply. Of the two, GTEs take precedent. As with other backshops, there are two schedules that are used to plan production. There is a quarterly schedule from the parts pool that is supposed to be followed on a pro-rata basis. This schedule is not taken as seriously as the schedule of actual GTE completion dates. Mr. Wade has found that he has to ~~be~~ beat the GTE schedule by about 3 days in order to stay out of hot water. There are 11 mechanics in Mr. Wades area and all work 1st shift. The -180 and -397 GTE starters comprise about 20% of the an workload and about 20% of the manpower requirements.

OPINION AND OBSERVATIONS

Again, a parts shortage is the primary problem in a backshop. In this case, the shortage of armatures is causing Mr. Wade to be very selective of the starters that he overhauls. This is understandable considering the circumstances. However, this increases the average flow time of a starter through the process and increases WIP. A more reliable supply of critical parts would help to prevent this problem. Also a more reasonable schedule based on production of GTEs might reduce schedule juggling.

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ENGINEERING NOTES

EMPLOYEE Parker DATE 11/5/90 PAGE NO. 133

RCC All SUBJECT Experimentation

11/5/90 -

We met with Susan Schattle and Danny Gonzales this morning to discuss experimentation and Task Order Status. MDMSC personnel present included Greg Gardner, Scott Vroman, Ken Premo, and myself. We discussed various issues, including the overall status of the Task Order. I gave Mr. Gonzales a list of the items referring to our engineering assessment task. This was per Ms. Scattle's instructions, who felt that we should provide a clear idea of the content of our assessment to Mr. Gonzales. Mr. Gonzales and Mr. Gardner were both required to sign this list. A copy was provided to Ms. Schattle at todays meeting. A signed copy of this list is enclosed. ~~As no one else has felt the need to comment on the necessity of such an informal agreement, I will keep my own opinions to mysel~~f. I will say that all of Mr. Gonzales' requests regarding engineering assessment appear on the list, as well as several others which we feel are important.

The remainder of the meeting dealt with items requested by Mr. Gonzales for experimentation. We agree with his initial list, as I have mentioned in previous notes on the subject, except for one item. This deals with the subject of rejections at final assembly of individual components. For various reasons we did not place this data in the model, although we did analyze existing data (in the form of log books provided to us by final test). I explained that a detailed analysis of all rejection data would be provided to Mr. Gonzales in our engineering assessment. Mr. Gonzales also requested that I provide him with a "Theoretical Best" model run, which we had discussed at an earlier date. I agreed to have this by Wendsday morning.

I also pointed out that the experimentation sheet listed one experiment which dealt with modeling the effects of bringing the "shortstack" workload in-house. Since this move has already been made, I suggested that we examine another workload, and use the data available from the shortstack move to configure the necessary changes in the ops files. Mr. Gonzales agreed that this was a good

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ENGINEERING NOTES

EMPLOYEE P Parker DATE 11/5/90 PAGE NO. 134

RCC All SUBJECT Experimentation

suggestion, and I reminded him that we still needed the log books which Mr. Perez maintains in the Parts Pool if we are to perform this analysis in a structured manner. He agreed to try and provide us the logs sometime later this week.

I spent the rest of the day working with Mr. Vroman on constructing our experimental methodology. Mr. Vroman will provide me with a listing of the exact experimental formats on Wensday, as he will be teaching a class on constructing and running the model, and other related VAX issues tomorrow (Tuesday).

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October 19, 1990

TO: Susan Schattle

MDMSC plans to provide/perform the following to complete the TO 15 engineering assessment:

1) Analyze rejection/rework points on GTE process and recommend a statistical process control plan to help the ALC reduce/eliminate the rework. The MDMSC SPC software used will be delivered to the Air Force at completion. Provide analysis of historical production practices for GTE processess (FY90 as period of study).

2) Study the vibration problem currently experienced in GTE final test, with documentation of said analysis, and provide such recommendations as appear feasible.

3) Have the MDMSC commercial maintenance specialist survey the commercial airline industry to determine the general extent of maintenance problems experienced with Garret GTEs. Make appropriate recommendations.

4) Have an MDMSC specialist in FPI processes examine the current and proposed GTE FPI process and make appropriate recommendations (will do our best to get him on-site).

5) Study and describe the potential use of CO_2 blasting in the GTE cleaning process.

6) Use the XCELL simulator software (instead of UDOS) to evaluate the feasibility of establishing machining cells, within the machine shop or the GTE repair area. The XCELL software and files (IBM compatible) will be delivered to the A.F. at the end of the T.O.

7). Estimate (ROM) current GTE - 180 & 397 WIP levels and make appropriate recommendations for reduction.

8) Evaluate use of a radio tracking system on GTE parts.

9) Analyze/Estimate probable effects of bringing in inter-service workload and make appropriate recommendations.

10) Analyze and report on standardizing the pick-up and drop-off points for GTE processes in building 329 and associated backshops.

Note: Where possible, a cost/benefit analysis will be performed for the above items.

Greg Gardner
MDMSC

Dan Gonzales
Danny Gonzales
SA-ALC

ENGINEERING NOTES

EMPLOYEE Parker

DATE 11/6/90

PAGE NO. 135

RCC A11

SUBJECT daily log

11/6/90 -

Since our office was to be used for teaching Mr. Vroman's Model course, I worked at home for most of the day. I finished my analysis of GTE rejection data, both end item and component parts. This data will be discussed in detail in the engineering assessment summary I am producing. I should have this summary completed next week (Tuesday). I also finished several pages of the draft CSR, which I will provide to Mr. Gardner for review. These will then be provided to Mr. Gonzales as soon as possible for both review and editorial comments.

I spent the rest of today entering the work sampling data into our EXCELL database. The analysis of this data to date will be provided in the engr. assessment summary I spoke of earlier.

DDB SECTION CODE

DDB PAGE NO. 86

ENGINEERING NOTES

EMPLOYEE Parker DATE 11/7/90 PAGE NO. 136

RCC All SUBJECT Experimentation

11/7/90 -

I provided Mr. Gonzales with a "Theoretical Best" model run this morning. Basically, I went into the model's ops files and changed all of the IN and OUT times to reflect 24.0 hrs (although the OUT times reflect a normal distribution around a deviation of +/- 8.0 hrs.). If this seems to long, please note that most areas involved in the GTE repair process presently only maintain one shift, or at least only designate GTE component processing to one shift. That leaves one eight hour shift for the movement of items between RCCs. I feel that this is a reasonable minimum for these model entries. Naturally, the process times for a GTE were dropped dramatically. If I were to be charged with streamlining the GTE process, this is the baseline I would aim for.

Mr. Vroman provided me with a copy of the experimental design format and naming conventions (which follows). I structured the Resource and Ops files to configure to the required parameters. I contacted Mr. Gonzales to remind him that we still need the Parts Pool log which Mr. Perez maintains. This is necessary since we are going to analyze how the moving of the "shortstack" workload in-house will affect production of this item, and then extrapolate this data to make assumptions based on bringing the -180 bearing housing in-house.

DDB SECTION CODE

DDB PAGE NO. 87

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GTE EXPERIMENTAL DESIGN FILE NAMES MATRIX							
		FILENAMES.	GTEPART.	GTERES.	GTEOPS.	GTEETC.	GTE__.OUT
	run#		PART	RES	OPS	ETC	OUTPUT
	1	E11	EA1	EA1	E1	E1	E11
	2	E12	EA2	EA1	E1	E1	E12
	3	E13	EA3	EA1	E1	E1	E13
	4	E14	EA4	EA2	E1	E1	E14
	5	E15	EA5	EA2	E1	E1	E15
	6	E16	EA6	EA2	E1	E1	E16
	7	E17	EA7	EA3	E1	E1	E17
	8	E18	EA8	EA3	E1	E1	E18
	9	E19	EA9	EA3	E1	E1	E19
	10	E21	EM1	EA1	E1	E2	E21
	11	E22	EM2	EA1	E1	E2	E22
	12	E23	EM3	EA1	E1	E2	E23
	13	E24	EM4	EA2	E1	E2	E24
	14	E25	EM5	EA2	E1	E2	E25
	15	E26	EM6	EA2	E1	E2	E26
	16	E27	EM7	EA3	E1	E2	E27
	17	E28	EM8	EA3	E1	E2	E28
	18	E29	EM9	EA3	E1	E2	E29
	19	E31	EA1	EM1	E2	E1	E31
	20	E32	EA2	EM1	E2	E1	E32
	21	E33	EA3	EM1	E2	E1	E33
	22	E34	EA4	EM2	E2	E1	E34
	23	E35	EA5	EM2	E2	E1	E35
	24	E36	EA6	EM2	E2	E1	E36
	25	E37	EA7	EM3	E2	E1	E37
	26	E38	EA8	EM3	E2	E1	E38
	27	E39	EA9	EM3	E2	E1	E39
	28	E41	EM1	EM1	E2	E2	E41
	29	E42	EM2	EM1	E2	E2	E42
	30	E43	EM3	EM1	E2	E2	E43
	31	E44	EM4	EM2	E2	E2	E44
	32	E45	EM5	EM2	E2	E2	E45
	33	E46	EM6	EM2	E2	E2	E46
	34	E47	EM7	EM3	E2	E2	E47
	35	E48	EM8	EM3	E2	E2	E48
	36	E49	EM9	EM3	E2	E2	E49

1 88

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ENGINEERING NOTES

EMPLOYEE Parker DATE 11/8/90 PAGE NO. 137

RCC 211 SUBJECT daily log

11/8/90 -

I spent today working on the CSR, as well as several other items of interest. I incorporated some new parts tracking information into the EXCELL spreadsheets. Mr. Vroman and I worked on experimentation, and we hoped to be ready to analyze our experimental results by Tuesday of next week. I also checked with Mr. Premo on his progress with the GTE vibration analysis. I called Mr. Gonzales to remind him that we still need Mr. Perez' parts pool log to structure our last experimental files on the bearing housing workload.

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ENGINEERING NOTES

EMPLOYEE Parker DATE 11/9/90 PAGE NO. 138

RCC All SUBJECT Experimentation

11/9/90 -

As Mr. Gonzales had not beed able to obtain the parts pool logs, I went to the parts pool and obtained copies of the Parts Pool Daily Count, which has been maintained for approximately a month. Unfortunately, this count only showed one "shortstack" being delivered to the parts pool in this time period. I was therefor unable to make any form of analysis which could be used in transferring a new workload into bld. 329. I went ahead and structured the bearing housing workload by making several assumptions. First, I assumed that only one person and associated equipment would be used in processing this workload, as is now the case in the machine shop. I changed the IN and OUT times in the model to reflect a 24.0 hr. turnaround, as I did earlier in the "Theoretical Best" model run. I further changed the ops files to reflect the manpower and equipment changes mentioned earlier. I then changed the resource files to reflect the necessary modification ("unique" manpower and equipment codes, and corrections to the availability of the related resources). I called Mr. Vroman and informed him of these facts, and he may now run experiments 19 through 36.

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ENGINEERING NOTES

EMPLOYEE Marker DATE 10/29/90 PAGE NO. [illegible]
RCC All SUBJECT [illegible]

10/29/90 -

I spent most of today reviewing the XCELL+ Factory Modeling System manual. I will begin inputting data into this model later this week. As previously mentioned, I intend to perform certain parts of our machine cell analysis using this software. This is simply to facilitate the performance of this part of our project, as we do not feel that it is necessary to structure UDOS files for this task at this time. The XCELL+ model is a limited simulator utilizing symbolic graphics in the construction of the proposed manufacturing process. It is its ease of information entry, as well as the usefulness of its graphical presentation format which influenced our choice of this software. We felt that, given the purely theoretical nature of our machining cell model, we would benefit from a simulation package which had a graphical presentation mode. This would facilitate the understanding and workings of such a system. However, this simulator does not begin to approach the analysis and construction power available to the UDOS simulation model. It simply allows us to easily produce a theoretical model using limited machines and other resources, while displaying the results of such a model in an easily understood and presentable format. Naturally, MDMSC will present a copy of this software (which is granted under a non-exclusive, non-transferable license for use on a single user computer, as per the manufacturer's specifications) to the ALC. The software package is designed for the personal use of a single engineer, but more powerful applications exist. Please refer to the software packaging information for more details.

I also performed tasks related to the parts tracking task, and reviewed certain data collected by Mr. Premo to be sent to our FPI specialist. We are still awaiting word on Mr. Gonzales' opinion of the new model runs, which he was provided on Friday. Mr. Gonzales is at a conference this week, and may be unavailable until Monday.

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ENGINEERING NOTES

EMPLOYEE P Parker DATE 10/30 PAGE NO. 1

RCC All SUBJECT [illegible]

10/30/90 -

Mr. Gardner spoke with Mr. Gonzales yesterday at the conference they are both attending. Mr. Gonzales expressed some concern over what he felt was the low occurrence of certain operations in the model ops files. He asked that we analyze the reasons for these O.F. inputs.

Basically, the data presented in the spreadsheets provided at the validation meeting last Friday is self-explanatory. The O.F.s found in the model represent the actual occurrence of the specific operations during the 1990 FY. The data was taken from our analysis of the historical documentation provided by stamped WCDs for this time period. This data is clearly shown in the updated spreadsheets we provided, as mentioned in my engineering notes of a week ago. While the occurrence factors presented may be considered representative only for the sample period we are studying, I would point out that the data is much more intrinsically accurate than that which would be gained from interview sources, as previously done in this project's history. I also should point out it is only the unique nature of the GTE process paperwork which makes this analysis possible, as we are tracking items <u>across</u> backshops, rather than in the RCC itself. In my opinion, most of the negative comments MDMSC has made about the use of WCD historical data in analyzing specific operations <u>within</u> an RCC is still valid.

I am eagerly awaiting Mr. Gonzales return to the base, as I would like to find out if we have a valid model or not. We need to begin experimentation as soon as possible.

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ENGINEERING NOTES

EMPLOYEE P Parker DATE 10/3 PAGE NO. 1

RCC All SUBJECT [illegible]

10/31/90 -

I made some minor changes to the latest model's ops file today. This was part of my effort to make sure that all of the inputted O.F.s were correct, per the concerns Mr. Gonzales expressed yesterday. I found no incorrect inputs on the occurrence factors themselves, but I did find a few cases where the listed resources for an operation were incorrect, or the actual operation time was itself incorrect. These are all extremely minor changes, as none of the operation IN and OUT times changed (these being the drivers in the GTE Process Model). This was a very detailed screening of the present ops file, using the ALC Labor Standards listing, as well as both the latest WCD formats and the older formats representing the historical documentation sample we analyzed. I feel that these changes correct any and all inaccuracies which were present. I am fairly confident that this is now one of the best structured models which we have produced in any Task Order, within the constraints placed by our present SA-ALC customer (i.e., replacement of interview data by ALC-provided Labor Standards, part tracking data). The model was reran with these changes, and the results are attached. Note the small change in Historical vs. Simulated flowtimes and throughput which these changes influenced. This very graphically points to our assertion that management in these various RCCs must eliminate the historically long flow times within their processes, flowtimes which apparently have little to do with the repair of the items, if they are to see any meaningful results from changes at the individual operation levels.

Scott and I spent the rest of the day discussing experimentation considerations for this RCC.

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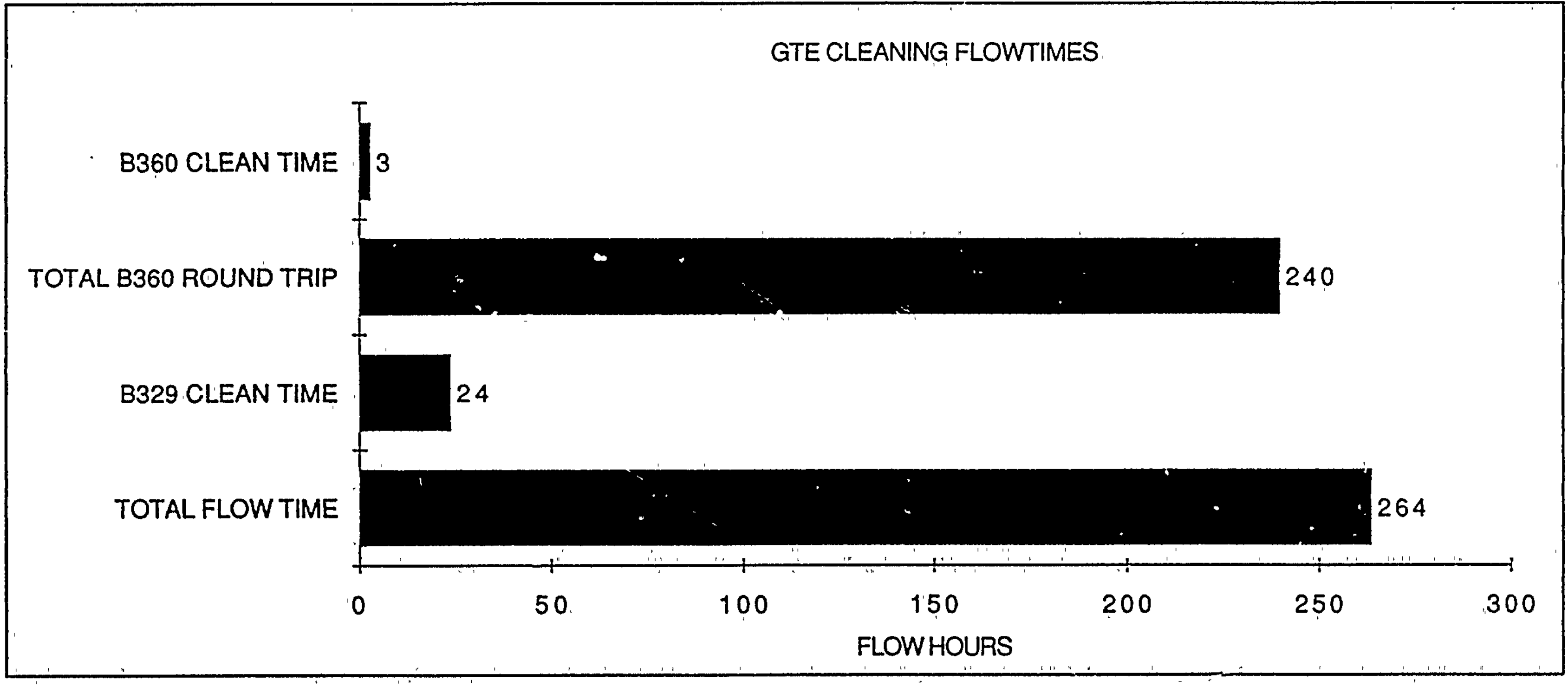
GTE CLEANING FLOWTIMES

COLD JET, INC.
TRIP REPORT

GREG GARDNER
10/16/90

I Visited Cold Jet, Inc. (Cincinnati, OH) w/Sadie McFarland. The purpose of the visit was to evaluate the application of a CO_2 blasting process to cleaning engine parts. Sample parts from MAE and MAT were used to test the application of this technology to the current SA-ALC cleaning processes.

CO_2 blasting equipment is currently manufactured by two companies - Cold Jet and Alpheus. The Alpheus technology is older. It's cleaning action is based largely on kinetic energy imparted to the cleaning surface by the high-pressure impact of CO_2 pellets. Cold Jet's process is optimized for maximum thermal effects and places less emphasis on kinetics. Cold Jet uses a lower blast pressure and heavier pellet density than Alpheus. Both manufacturer's equipment is currently installed in AFLC.

Alpheus has a blast booth installed at OC-ALC. During MDMSC's evaluation of OC-ALC cleaning technology (1 Aug 90), OC-ALC engineers reported that the Alpheus process worked but required a chemical clean/strip prior to CO_2 blasting. The equipment was described as reliable and they complimented Alpheus on their customer support.

Cold Jet equipment has been purchased by WR-ALC and installation has begun. The equipment is not yet in use (due apparently to facilities problems - insufficient electrical wiring in the WR-ALC hangar), and MDMSC has no performance data.

In an unrelated effort, McDonnell Aircraft Company (McAir) conducted an evaluation of both vendors and recommended Cold Jet as the process of choice for aviation applications. A copy of this report was provided to MAE engineering staff.

The Cold Jet equipment consists of:

Cold Jet Blast Unit:

This unit produces the CO_2 pellets (from liquid CO_2) and provides nozzle pressure (regulated) for blasting. These units come in single, double, and triple nozzle configurations. The facilities foot print of these units is 4 x 6 (single) or 4 x 8 (double/triple). The input requirements are:

Electrical power (consumption rate UNK)
Liquid CO_2 (nominal temp = 0°F.)
Pressurized air (pressure is as required - max rating is 350 psi). This can be shop air or pressurized dry air or another inert gas.

These units are reported as highly reliable. While no MTBF/MTTR figures were immediately available, Cold Jet reported that 95% of all unscheduled failures were repairable in less than 20 min. The vendor provides a 1 year warranty, plus a 24 hour guarantee on return to service (a 24 hour hotline is maintained). The units are maintained on a 100 (operating) hour PM schedule.

MAX CO_2 consumption is 1400 lbs/hour.

Blast Nozzles:

The units are equipped with a broad assortment of nozzles for various applications. Nozzles can be customized to fit specific applications. The nozzles can be changed by the operator in 5 - 10 seconds without shutting down the unit (Blasting must stop, however, for safety reasons). The nozzles are connected to the blast unit by insulated cryogenic pressure hose. The nominal length for this hose is 60 - 100 ft but this can be increased to over 300 ft if necessary, or shortened as required.

Flow splitter units are available which allow one blast unit to deliver pellets through multiple nozzles or switch between nozzles as required. MDMSC saw a cleaning station designed for Ford, Inc. (stripping automobile conveyor carriers) that used one blast unit to support multiple nozzles in various arrangements. The plumbing was very involved but appeared well constructed.

Child Blast Unit

This is a portable unit which does not produce its own pellets. It stores pellets from a pelletizer or a blast unit and delivers them to the part. Those units contain about 700 lbs of CO_2 pellets.

CO_2 Tank Unit

The tank contains liquid CO_2 maintained at 0°F. This is pure (food-grade) CO_2 reclaimed by the manufacture (Liquid Carbonic) from other manufacturing processes. Delivery pressure is 300 psig.

Costs for this equipment was provided as:

Single Blast Unit	-	$ 150K
Double	-	$ 250K
Triple	-	$ 330K
Child	-	$ 50K

CO_2 2.5 ¢/lb delivered

Cold Jet reports their equipment is currently used by Delta, Northwest AL, Federal Express, and Boeing Corp.

A variety of parts were cleaned, with various degrees of success. The details of the cleaning process (and results) are documented on the video tape entitled "Cold Jet/MDMSC/IPI Test 16 Oct 90."

The process was extremely effective in removing grease, oils, heavy carbon/coking, gaskets and sealants, and paint from heavier - substrate items.

The process was less effective in removing primer from thin sheet metal parts, although it was able to accomplish this.

The process was ineffective at removing burnt carbon that had bonded with the metal substrate surface. It did not produce white metal.

- MDMSC will provide video and photo documentation on these parts to MAE/MAT engineers.

- The engine blade blasted will be shown to the MDMSC FPI expert whenever I can get him down here. We want to know if it could be inspected by a modified FPI process.

- Will ask Lisa Baumgardner to get details on NWA, Delta, and Fed Ex use of the technology (and how they really like it).

ENGINEERING NOTES

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RCC MATPS1 SUBJECT Inspection

Following is a breakdown of the workstations in the MATP31 inspection area according to the supervisor in the area, Albert Musquiz.

- There are a total of 17 workstations.
- Seven of the stations are APIS stations and one is a micro 4 station.
- The rest of the stations are visual and conventional dimension stations.
- The APIS and micro 4 stations are almost always fully utilized.

7 - APIS stations
1 - micro 4 stations
9 - conventional stations
17 total stations

Misc Notes:

- Mr Musquiz says that all of the 15 total inspectors in the GTE inspection area can serve as alternates for each other
- Mr. Musquiz believes that the current method of payment to his inspection area is unfair. Currently, his area is paid a given amount for each GTE that is completed. However, because inductions are significantly greater in

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ENGINEERING NOTES

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RCC MATPSI SUBJECT Inspection

number than are the engines that are completed and sold, inspection is required to work "exta" parts without compensation.

- In addition, Mr Musquiz also believes that his inspection area is often used as a "dumping ground" for undesirable parts. He stated that it is too easy for a shop to get rid of unwanted parts by simply removing the paperwork (WCD) and dropping it off at inspection (on the sly). Inspection has no choice but to attach new paper work and re-inspect the part. This add's to the uncompensated burden that the inspection area must bear.

- Mr. Musquiz believes that the current scheduling system is illogical and ineffective. He showed me an example of a schedule of parts he was to deliver. The schedule appeared to be filled in based more upon symetry and aesthetic appeal than reality. (an example of this schedule follows). Mr. Musquiz stated that often it is impossible to follow this schedule because it doesn't reflect the actual workload that is delivered to his area from cleaning. The inspection area is forced to clean whatever parts are delivered to them, makein the current scheduling system useless.

- Also, Musquiz stated that the current scheduling system is ill timed in regards to when parts are inducted. For example, if there is need for the delivery of a particular type of engine within a certain time frame,

ENGINEERING NOTES

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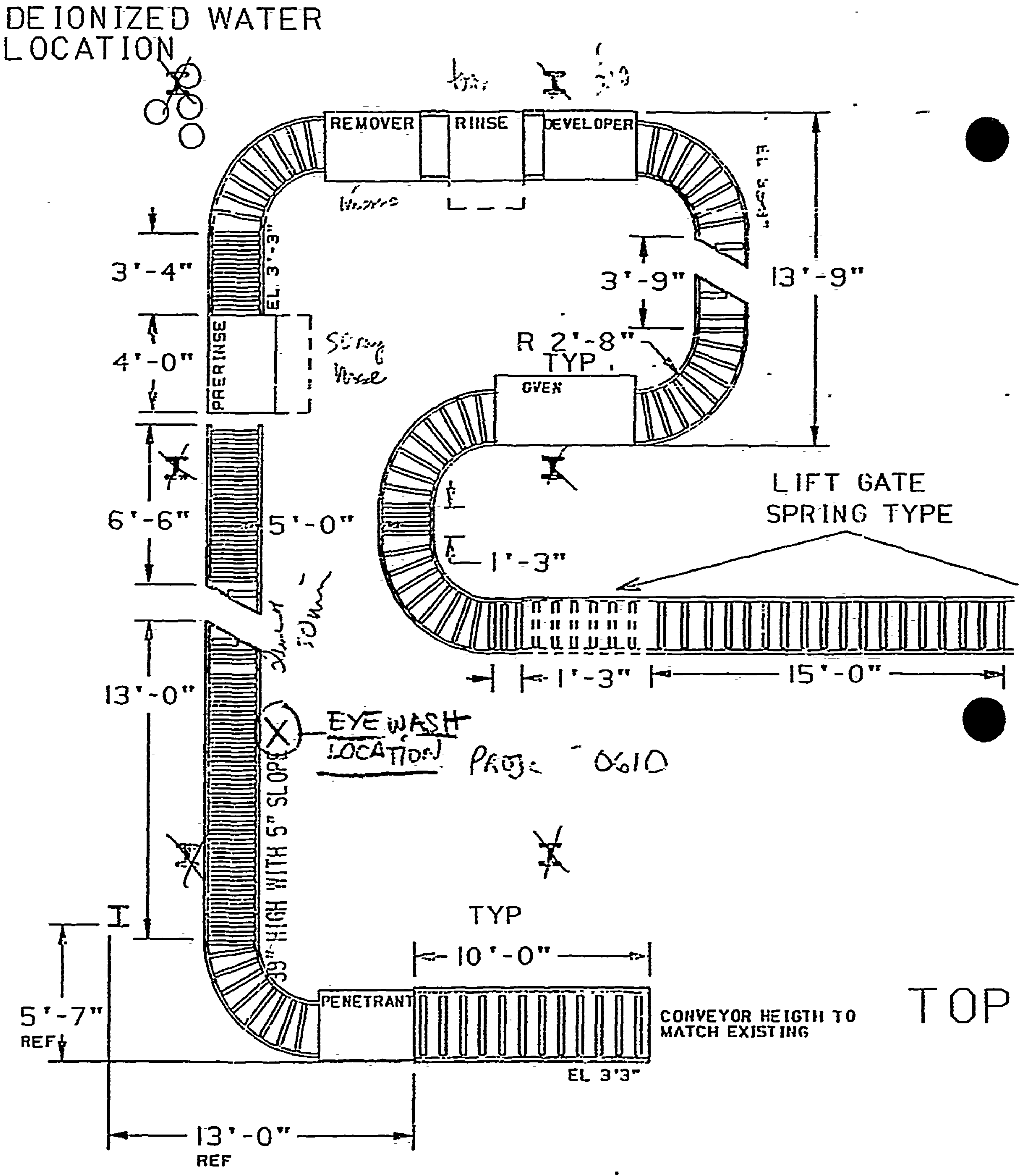
RCC MATPSI SUBJECT Inspection

that engine type is pushed throughout the entire GTE repair system, including the dis-assembly area. Often, by the time sufficient numbers of parts of the desired engine are delivered to inspection, the need for these parts has been satisfied by other areas. This leaves the inspection area to inspect large quantities of parts that are currently not needed by the System.

OPINION:

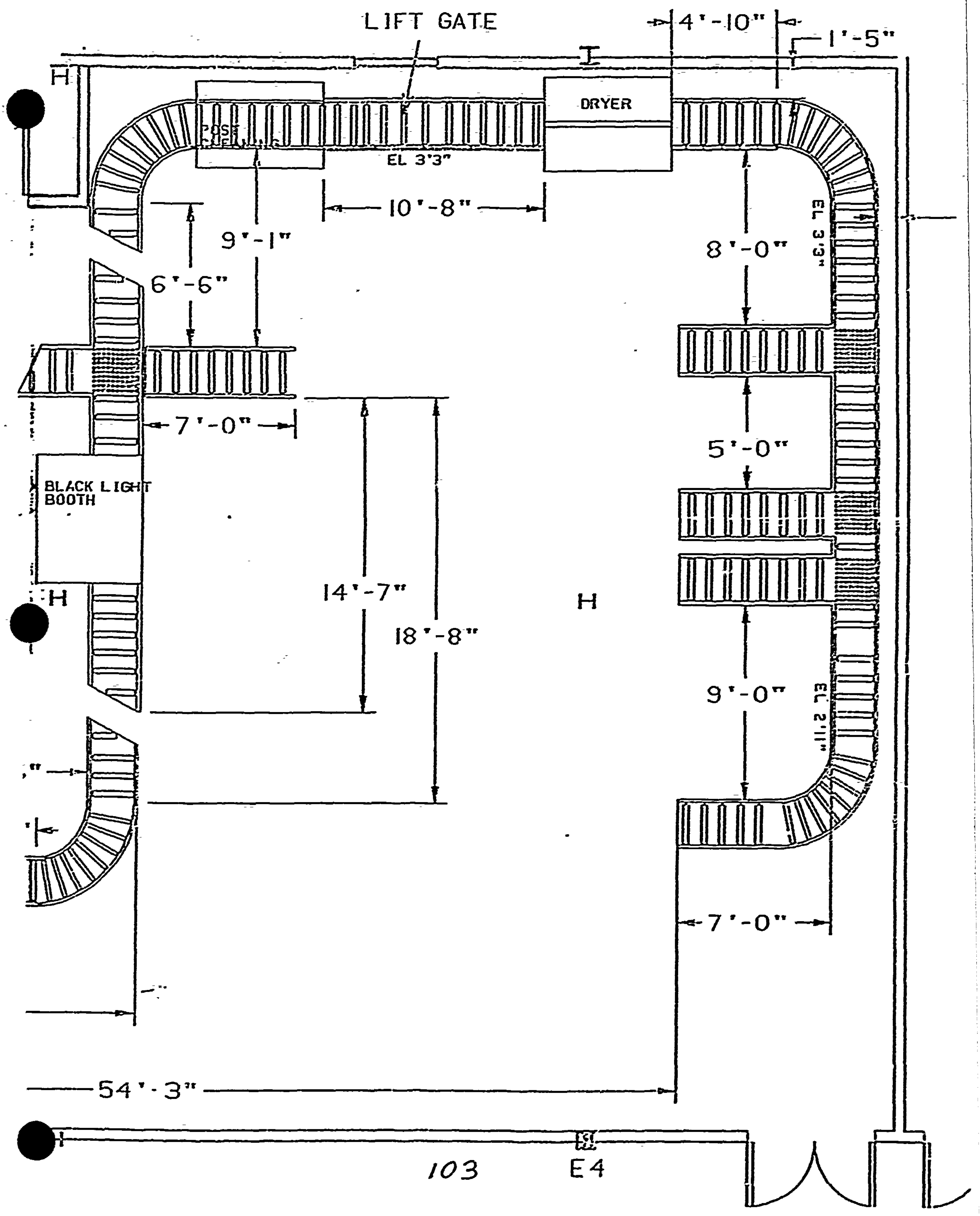
The current problems MATPSI inspection is having with uncompensated workload (excess inductions), parts dumping, unrealistic schedules, and ill timed parts surges are all caused by the lack of control over the entire GTE repair process. With the current system, parts are allowed to "roam" from shop to shop and are for all practical purposes lost until they finally reach the parts pool. In addition, there appears to be very little accountability by the shops for the quality of workmanship or for the amount of time a part spends in a shop. This lack of control and accountability makes it almost impossible to know or predict the amount of time it takes to work a part and equally difficult to adequately schedule work. The current scheduling method appears to be to cram as many parts as possible into the system to assure a sufficient supply of "cherry" parts to maintain production.

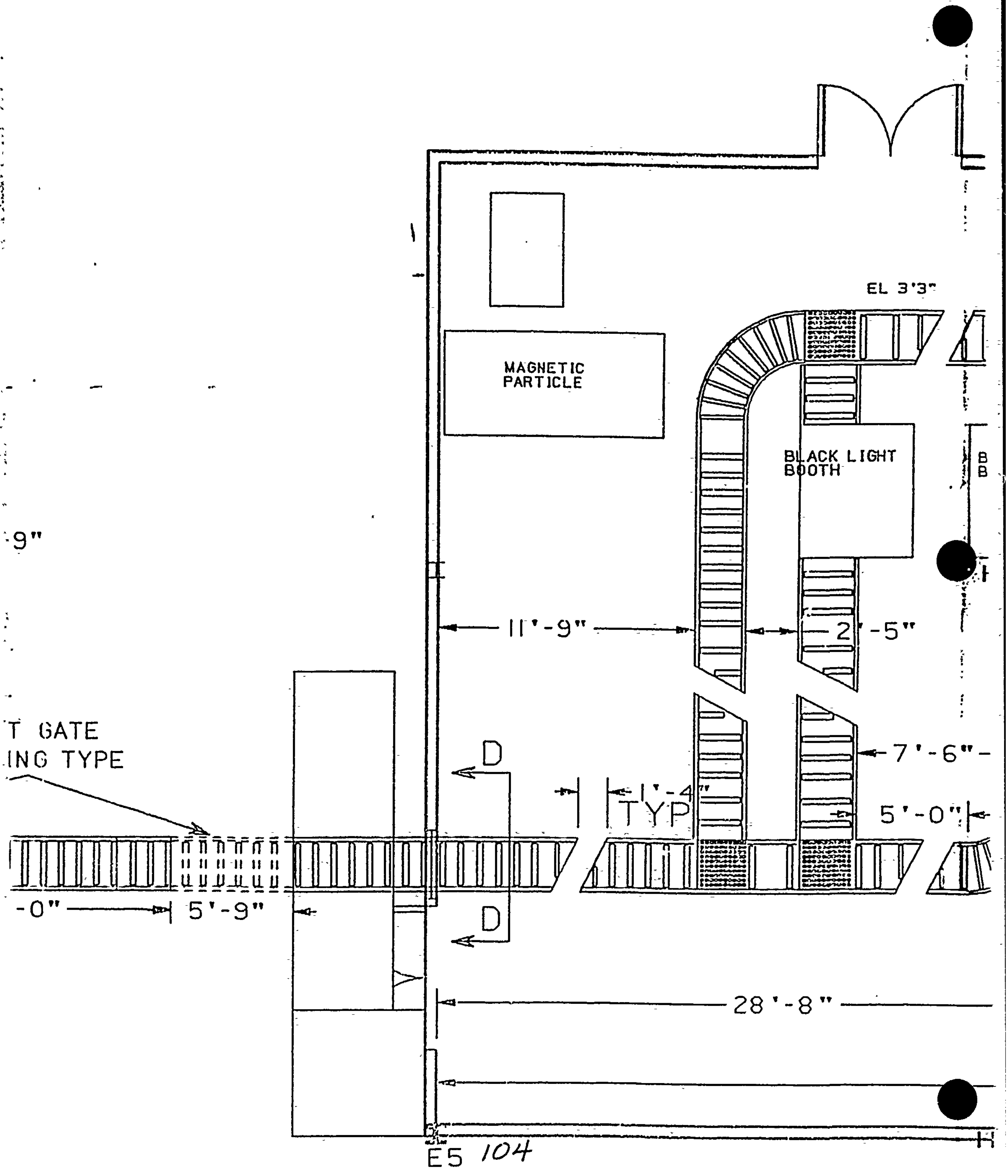


PENETRANT APPLICATION AREA

LEGEND:

▥ CONVEYOR WITH DRIP PANS


LIFT GATE
4'-10"
1'-5"
H
DRYER
POST
EL 3'3"
10'-8"
9'-1"
6'-6"
8'-0"
EL 3'3"
7'-0"
5'-0"
BLACK LIGHT BOOTH
H
14'-7"
18'-8"
H
9'-0"
EL 2'11"
7'-0"
54'-3"
E4



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TOP CONVEYOR

CHEMICAL/HAZARDOUS MATERIAL REQUEST *(Type or Print With Pen Only)*	1. TYPE REQUEST *(Check one)* ☐ INITIAL ☒ RENEWAL	2. CIMN NUMBER 0329-270

3. ORGANIZATION SYMBOL SA-ALC/MATPSI	4. FUNCTIONAL CODE MTPS9Q	5. OPERATION CODE *(Shop)* MA270	6. ZONE NUMBER DEXX-0780
. WORKCENTER TITLE PARTS INSPECTION		8. BUILDING NUMBER 0329	9. LOCATION *(Be specific)* COL E-4

10. NSN/LSN 6850PWS-1	11. NOUN DEVELOPER, TYPE I, FORM B	12. UNIT OF ISSUE 1 00/LB/LB
13. PART NUMBER AND TRADE NAME	14. MATERIAL SPEC *(State any Mil-Spec, Fed-Spec etc., leave blank if unknown)* MIL-I-25135D	15. MONTHLY REQUIREMENT 01
16. MANUFACTURER'S NAME	17. MANUFACTURER'S ADDRESS *(City and State)*	18. CAGE/FSCM NUMBER

19. JUSTIFICATION *(State T.O., callout, manufacturer's callout, work specs, drawings, etc.,)*
TO 33B-1-1

20. PROCESS *(Fully describe work activity and process in which this material is used, identify method of application and applicable end items)*
FLUORESCENT PENETRANT INSPECTION

20a. NEW PROCESS *(Check one)*
☐ YES ☒ NO

21. DISPOSAL METHOD FOR WASTE GENERATION *(Check one)*

☐ CONSUMED IN USE ☐ IWTP ☐ OTHER *(Explain)*
☒ DRUMMED WASTE ☐ BULK WASTE

22. RESPONSIBLE SUPERVISOR *(Name, orgn, phone)* DIONICIO V. BORREGO WS-09 MATPSI 9053	22a. SIGNATURE	22b. DATE 01/18/90

23. I CERTIFY THE MATERIAL IS REQUIRED AS STATED ABOVE *(Provide additional remarks if necessary)*

23a. CERTIFYING OFFICIAL *(Name, title, orgn, phone)* MANUEL R. DIEGO, IND. ENGR, MATEA, 54323	23b. SIGNATURE Manuel R. Diego	23c. DATE 18 Jan 90

DIRECTORATE OF MAINTENANCE FORWARD TO APPROPRIATE MAQ BRANCH
OTHER ORGANIZATIONS FORWARD TO BIOENVIRONMENTAL ENGINEERING SERVICES

24. CONTROL NUMBER 89336Y04	25. MATERIAL REVIEW CODE 7U	26. HAZARD CLASS/STORAGE CODE NONE SPECIFIC	
27. DISPOSAL CODE IWTP	28. PROCESS CODE INSP	29. REVIEW DATE 01/90	30. NEXT REVIEW DATE 9207

31. REMARKS
REPLACES 6850PD76

Based on the information provided, this chemical is found to be a valid requirement for use as stated above. A copy of this form has been forwarded to Bioenvironmental Engineering Services. Improper use or lending of this material is prohibited.

2. REVIEWING OFFICIAL *(Name, title, orgn, phone)* RALPH ROGERS QUALITY ASSURANCE SPEC. MAQV, 5-4041	32a. SIGNATURE Ralph E. Rogers

AFLC FORM 611, OCT 88 105 COPY 1 - REQUESTING ACTIVITY

329-04

CHEMICAL MATERIAL REQUEST/AUTHORIZATION (0094)

1. ORGN SYMBOL MATPSI	2. FUNC CODE MTP59U	3. OPER CODE TPSI2	4. ORGANIZATIONAL TITLE Starter Inspection

5. BLDG / LOCATION 329 E4	6. NSN / LSN 6850P0134322059	7. UI DR	8. SPECIFICATION MIL-6866	9. MO REQ 3 DR.

10. NOUN
PENETRANT

11. JUSTIFICATION (*State T.O. callout, mfg callout, work specs. etc.*)
T.O. 2JA16-2-3, PARA. 5-12

12. MANUFACTURER AND PART NUMBER

13. PROCESS (*Fully desribe material ~~application~~, ref end items, etc.*)
C/A/W T.O. 33B-1-1 AND 2JA16-2-3

13. RESPONSIBLE SUPERVISOR (*Name, grade, orgn, phone*)
DIONICIO V. BORREGO, WS09 MATPSI 5311

SIGNATURE

I CERTIFY THIS MATERIAL IS REQUIRED AS STATED ABOVE

14. CERTIFYING OFFICIAL (*Name, grade, organization, phone*)
MANUEL R. DIEGO, GS-11, MATEA, 54323

SIGNATURE
Manuel R. Diego 16 NOV 87

MAINTENANCE ORGANIZATIONS WILL FORWARD TO ENVIRONMENTAL AND INDUSTRIAL SAFETY SECTION (MAQCE), BLDG 308, ROOM 227, EXT 5-4041

16. REMARKS

17. NAME AND TITLE OF REVIEWING OFFICIAL
YVETTE ARGUIJO
QUALITY ASSURANCE SPECIALIST

SIGNATURE
Yvette Arguijo

FORWARD TO BIOENVIRONMENTAL ENGINEERING SERVICES (SGB), BLDG 305, EXT 5-7544

18. MRC D033 / D002A D033 -U	19. MSDS Yes, FNX	20. WORK PLACE IDENTIFIER DEXX - 0780

21. PRIMARY HAZARDOUS MATERIAL(s)
Alkyl Naphthalene, Diphenol Octyl Phosphate, Parraffin Oil

22. PROTECTIVE EQUIPMENT REQUIRED, IF ANY (*Check all applicable blocks*)

TYPE	SPECIFIC PROTECTION									
SKIN	☒	BARRIER CREAM	☒	GLOVES	☐	APRON	☐	CLOTHING	☐	RUBBER BOOTS
EYES	☒	SAFETY GLASSES	☐	SAFETY GOGGLES	☐	CHEMICAL SPLASH GOGGLES			☐	FACE SHIELD
RESPIRATOR	☐	ORGANIC VAPOR	☐	SPRAY PAINT	☐	METAL FUME / TOXIC DUST				

OTHER (*Specify*)

23. EMERGENCY PROCEDURES REQUIRED, IF ANY
Flush eyes or skin with plenty of water - wash with soap and water. Call for medical assistance if needed.

24. REMARKS
Avoid skin and eye contamination; Practice good personnel hygiene (handwashing); Provide good general ventilation of area; Wear protective equipment as required

25. NAME AND TITLE OF APPROVING OFFICIAL MELVIN E. PEREZ, JR. Industrial Hygienist	SIGNATURE Melvin E. Perez, Jr	26. APPROVAL DATE 8801	27. EXPIRATION DA 9301

AFLC FORM 3916, APR 87 (TEST-1) PREVIOUS EDITION WILL BE USED.

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1 — REQUESTING ACTIVITY

28 OCT 1987

329-6 **CHEMICAL MATERIAL REQUEST/AUTHORIZATION (0094)** Starter Inspection

1. ORGN SYMBOL MATPSI	2. FUNC CODE MTPS9U	3. OPER CODE TPSI2	4. ORGANIZATIONAL TITLE NON-DESTRUCTIVE TESTING

5. BLDG. LOCATION B/329 E4	6. NSN/LSN 68500[illegible]11210946	7. UI DR	8. SPECIFICATION MIL-I-6866	9: MO REQ 3 DR

10. NOUN
PENETRANT

11. JUSTIFICATION (*State T.O. callout, mfg callout, work specs, etc.*)
T.O. 2JA3-50-3, PARA. 5-11
TO. 2JA16-3-3, PARA. 5-12
TO. 2JA16-3-3, PARA 5-12

12. MANUFACTURER AND PART NUMBER
MET-L-CHEK
1639 EUCLID ST
SANTA MONICA, CA, 90404

13. PROCESS (*Fully desribé material application, ref end items, etc.*)
TO BE APPLIED I/A/W T.O. 33B-1-~~[illegible]~~1 AND MIL-I-6866

13. RESPONSIBLE SUPERVISOR (*Name, grade, orgn, phone*)
DIONICIO V, BORREGO WS09 MATPSI 55311

SIGNATURE

I CERTIFY THIS MATERIAL IS REQUIRED AS STATED ABOVE

14. CERTIFYING OFFICIAL (*Name, grade, organization, phone*)
MANUEL R. DIEGO, GS-11, MATEA, 54323

SIGNATURE
Manuel R. Diego

MAINTENANCE ORGANIZATIONS WILL FORWARD TO ENVIRONMENTAL AND INDUSTRIAL SAFETY SECTION (MAQCE), BLDG 308, ROOM 227, EXT 5-4041

16. REMARKS

17. NAME AND TITLE OF REVIEWING OFFICIAL
Hyland Lee, Environmental Engineer

SIGNATURE
13 NOV 1987

FORWARD TO BIOENVIRONMENTAL ENGINEERING SERVICES (SGB), BLDG 305, EXT 5-7544

18. MRC D033 / D002A D033 -U	19. MSDS Yes, FNX	20. WORK PLACE IDENTIFIER

21. PRIMARY HAZARDOUS MATERIAL(s)
Paraffin oil, ehtoxylated octylpheol, fluroescent dye.

22. PROTECTIVE EQUIPMENT REQUIRED, IF ANY (*Check all applicable blocks*)

TYPE	SPECIFIC PROTECTION								
SKIN	☒	BARRIER CREAM	☒	GLOVES	☐	APRON	☐	CLOTHING	☐ RUBBER BOOTS
EYES	☒	SAFETY GLASSES	☐	SAFETY GOGGLES	☐	CHEMICAL SPLASH GOGGLES			☒ FACE SHIELD
RESPIRATOR	☐	ORGANIC VAPOR	☐	SPRAY PAINT	☐	METAL FUME / TOXIC DUST			
OTHER (*Specify*)									

23. EMERGENCY PROCEDURES REQUIRED, IF ANY
Flush eyes or skin with plenty of water - wash with soap and water. Call for medical assistance if needed.

24. REMARKS
Avoid skin and eye contamination; Practice good personnel hygiene (handwashing); Provide good general ventilation of area; Wear protective equipment as required

25. NAME AND TITLE OF APPROVING OFFICIAL ARTHUR HYMAN Industrial Hygienist	SIGNATURE	26. APPROVAL DATE 8801	27. EXPIRATION DATE 9301

AFLC FORM 3916, APR 87 (TEST-1) PREVIOUS EDITION WILL BE USED 1 — REQUESTING ACTIVITY

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*

329-6 **CHEMICAL MATERIAL REQUEST/AUTHORIZATION (0094)** Eastern Inspection

1. ORGN SYMBOL MATPSI	2. FUNC CODE MTP59U	3. OPER CODE TPSI2	4. ORGANIZATIONAL TITLE NON-DESTRUCTIVE TESTING	
5. BLDG. LOCATION B/329 E4	6. NSN/LSN 6850,00,782,2737	7. UI DR	8. SPECIFICATION MIL-I-6866	9. MO REQ 3 DR.

10. NOUN EMULSIFIER	11. JUSTIFICATION (*State T.O. callout, mfg callout, work specs, etc.*) T.O. 2JA3-50-3, PARA. 5-11 T.O. 2JA16-2-3, PARA. 5-12 T.O. 2JA16-3-3, PARA. 5-12
12. MANUFACTURER AND PART NUMBER MET-L-CHEK CO. 1639 EUCLID ST. SANTA MONICA, CA. 90404	

13. PROCESS (*Fully desribe material application, ref end items, etc.*)

TO BE APPLIED I/A/W T.O. 33B1-1 AND MIL-I-6866

13. RESPONSIBLE SUPERVISOR (*Name, grade, orgn, phone*) DIONICIO V. BORREGO WS09 MATPSI 55311	SIGNATURE

I CERTIFY THIS MATERIAL IS REQUIRED AS STATED ABOVE

14. CERTIFYING OFFICIAL (*Name, grade, organization, phone*) MANUEL R. DIEGO, GS11, MATEA, 54323	SIGNATURE Manuel R. Diego 20 Oct 87

MAINTENANCE ORGANIZATIONS WILL FORWARD TO ENVIRONMENTAL AND INDUSTRIAL SAFETY SECTION (MAQCE), BLDG 308, ROOM 227, EXT 5-4041

16. REMARKS

17. NAME AND TITLE OF REVIEWING OFFICIAL Hyland Lee, Environmental Engineer	SIGNATURE 13 NOV 1987

FORWARD TO BIOENVIRONMENTAL ENGINEERING SERVICES (SGB), BLDG 305, EXT 5-7544

18. MRC D033 / D002A D033 -U	19. MSDS Yes, FNX	20. WORK PLACE IDENTIFIER DEXX-0280

21. PRIMARY HAZARDOUS MATERIAL(s)

Solvents, Alkyl aryl polyethoxide ester surfactant

22. PROTECTIVE EQUIPMENT REQUIRED, IF ANY (*Check all applicable blocks*)

TYPE	SPECIFIC PROTECTION				
SKIN	☑ BARRIER CREAM	☑ GLOVES	☐ APRON	☐ CLOTHING	☐ RUBBER BOOTS
EYES	☑ SAFETY GLASSES	☐ SAFETY GOGGLES	☐ CHEMICAL SPLASH GOGGLES		☐ FACE SHIELD
RESPIRATOR	☐ ORGANIC VAPOR	☐ SPRAY PAINT	☐ METAL FUME / TOXIC DUST		
OTHER (*Specify*)					

23. EMERGENCY PROCEDURES REQUIRED, IF ANY

Flush eyes or skin with plenty of water - wash with soap and water. Call for medical assistance if needed.

24. REMARKS

Avoid skin and eye contamination; Practice good personnel hygiene (handwashing); Provide good general ventilation of area; Wear protective equipment as required

25. NAME AND TITLE OF APPROVING OFFICIAL MELVIN E. PEREZ, JR. Industrial Hygienist	SIGNATURE Melvin E. Perez Jr.	26. APPROVAL DATE 8801	27. EXPIRATION DATE 9301

AFLC FORM 3916, APR 87 (TEST-1) PREVIOUS EDITION WILL BE USED 1—REQUESTING ACTIVITY

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ENGINEERING NOTES

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RCC MATPSI SUBJECT Automatic FPI line

- Manual Diego (5-4667) is the engineer who wrote the original draft letter describing the automated FPI line (a copy of this letter follows these notes).

- Following are some brief highlights of a conversation with Mr. Diego.

CURRENT SYSTEM

- located in bld 329 next to inspection area
- current system is a bottleneck in the GTE repair process and has a low volume flow rate.
  - processes are very labor intensive and are susceptible to manpower interruptions (sickness, etc)
    - manual air hoists are used to put parts in and out of tanks.
    - tank dwell and curing time for the penetrant are timed manually, which can cause some timing errors.
    - there is insufficient queue space between tanks. This causes the entire FPI process to stop while waiting for the penetrant to cure.
    - about 5-6 people are currently used just moving and dipping parts!
  - Current system wastes chemicals because of the dipping process. This allows contamination of the fluids. The electrostatic spray system of penetrant application that is used in the engine line in building 360 wastes considerably less penetrant.

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ENGINEERING NOTES

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RCC MATPS1 SUBJECT Automatic FPI Line

DESIRED SYSTEM

The desired system would be implemented in two phases. The first phase would include the installation of all of the hardware. At this phase the automatic cleaning, penetrant application, rinsing and drying portions of the system would be functional for all the parts that went through the FPI process. In addition, the first phase would include the completely automated inspection of 50-100 of the highest volume engine parts. the hardware installation and computer programing for the initial 50-100 parts would be done by the contractor awarded the installation contract. The second phase of the installation would be the programing of the system for the automated inspection of the rest of the parts. This work would be done in house by ALC personel. The system software must be sufficiently flexible and user friendly to permit program inputs and changes by ALC personel as they are needed.

The part preparation portion of the process will be completely automatic with no interaction from workers up until the point that the parts are ready for inspection by the robotic arm. At this point, the operator will place the part on a positioning fixture and input the type of part. From that point onward the inspection will be automatic using preprogramed logic and artificial intelligence. Any defects that are found will be recorded by the system and confirmed by human inspection.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 10-25-90 PAGE NO. 3/

RCC MATPSI SUBJECT Automatic FPI line

The new automated FPI system will be installed in the same location as the old system in bld 329.

The desired system will contain the following elements and will be fully automatic:

1. Preconditioning — a detergent wash followed by de-ionized H_2O rinse and drying process.

2. Penetrant application — penetrant will be applied using an electrostatic spray system

3. Spray cleaning — Cleaning using a spray system rather than dipping

4. Dryer — dry using a hot convected air method

5. Staging area for baskets of parts that are ready for the automated inspection process

6. Positioning fixture to locate parts for pickup by the robotic arm.

7. Automatic inspection station which includes:
    A. Robotic arm - sufficiently dexterous accomplish the inspection task
    B. fiber optic lens system
    C. computer and software capable of detecting, quantifing, and analyzing flaw using artificial intelligence. Computer must have sufficient memory to store information for apx 600-700 differant parts and must be easily programed by ALC personel.

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REPAIR TECHNOLOGY PROJECT

1. Title. Automated Fluorescent Penetrant Inspection Process (AFPIP)

2. Objective. The project will cover the automation of the entire process of Fluorescent Penetrant Inspection including the black light inspection. The computer will scan the surface of the aircraft part for any flaw. With the use of Artificial Intelligence, the computer will determine if the part is acceptable.

3. Cost of the Effort. Estimated AFSC MANTECH $ 1,500,000.00 needed to complete proposed project.

4. Description of the Technology Deficiencies:

a. Maintenance & Repair Operations:

(1) The Technology Repair Division is involved in the overhaul of 17 models of Aircraft Starters, 13 models of Gas Turbine Engines, the F15 Secondary Power System and the F16 Engine Start System. The Weapon Systems that are supported are: F100, B52, C135, A10, KC135, F4, F111, C130, F106, F101, C141, C140, C5, F15, & F16.

(2) The Maintenance Operation involves the overhaul of the assets mentioned in the preceding paragraph. The overhaul process includes disassembly, cleaning, fluorescent penetrant inspection, dimensional and visual inspection, repair (when needed), and assembly.

The required fluorescent penetrant inspection involves immersing a basket full of parts in 3 chemical filled tanks, water rinsing the parts twice under black light, drying the parts in electric dryers, and finally inspecting parts under black light (in a dark room) for cracks and imperfections.

b. Technology Deficiencies:

(1) There is no uniformity in the way black light inspection is being done. By automating this process, the computer will detect the flaws or cracks, quantify the crack, compare the results with technical order guidelines, and determine if flaw or crack is within or outside technical order guidelines.

(2) The chemicals are presently being replenished every month because of contamination or weakness in its concentration.

(3) Present set up exposes the operator to the hazards of the chemicals used in this process. Eliminating operator exposure to these chemicals will be a welcomed change.

(4) There is lack of uniformity in the application of the chemicals on parts in Bldg 329. There has excessive amount of penetrant in some instances and other times there is not enough of penetrant chemical.

(5) There is no uniformity in the rinsing process. This process is tedious in most cases. The operator has to work in a dark room with the black light on and rinse excess penetrant chemicals off the part.

(6) The present set up requires the operator to push baskets on the roller conveyor, attach the basket to the overhead conveyor for immersing in the chemical tanks, and lifting baskets from one station to another.

(7) This area is a bottleneck in Bldg 329, Kelly AFB. The volume of parts needing fluorescent penetrant inspection overwhelms the existing set up and the personnel involved in this process. These personnel are often requested to work overtime to catch up with the flow of parts.

c. Suggested Approach: A fully automated fluorescent penetrant inspection (FPI) line will resolve all the deficiencies that were discussed. The system will be similar to the IBIS in Bldg 360, Kelly AFB. The major difference is the automation of the black light inspection process. This will include a robotic arm that will pick up the part to be black light inspected, place it in the field of view of the fiber optic lens, detect flaw, quantify the flaw, evaluate the flaw, determine if flaw is acceptable with use of artificial intelligence, and print results of the inspection process. An automated material handling system will be used to move the baskets and most importantly to obtain the correct dwell time for the chemicals to cure. By utilizing electrostatic spray system in the application and dispensing of the chemicals, it will reduce chemical waste by an estimated 60%, eliminate personnel contact with the chemicals and have a uniformly applied coat of penetrant, remover and developer chemicals on the part.

5. Only existing system coming close to the suggested approach is the IBIS in Bldg 360, Kelly AFB. Item was contracted to General Electric. Project engineer for the IBIS is James Wheatley, 512 925 7716.

6. Policies and Procedures Guidance: All policies and guidance for the overhaul of the assets are provided by the technical order of each respective end item. Present process and procedure can be implemented by amending a statement in the technical orders which will allow electrostatic application of the chemicals.

7. Cost and Benefits:

a. Workload.	FY 89	Cartridge and Air Turbine Starters..	3,232 units
		Gas Turbine Engines..	1,174 units
		F-15 Secondary Power System..	1,681 units
		F-16 Engine Start System..	394 units
	FY 90	Cartridge and Air Turbine Starters..	952 units
		Gas Turbine Engines..	835 units
		F-15 Secondary Power System..	1,330 units
		F-16 Engine Start System..	400 units

The following items are projected workload:

FY 91	Cartridge and Air Turbine Starters..	852 units

ENGINEERING NOTES

EMPLOYEE ______ DATE ______ PAGE NO. ______

RCC ______ SUBJECT ______

REWORK (ie: rejects)

- 1 mechanic (Wg 9 or 10) does the work
- Engines are reworked until they are fixed they are not sent back to dissassembly
- Rework times (apx):

397 12hr ± 2hrs

180 16 hr ± 2 hrs

- initial trouble shoot in test cell takes (1) Wg 9 apx 30 min ± 15 min
- trouble shooting in ~~shop~~ final assembly takes (1) Wg 9 about 30 min ± 15 min

STEPS IN REWORK:

(1) initial trouble shoot in test cell
(2) moved to final assembly
(3) trouble shoot in final assembly area
(4) dissassembly
(5) repair
(6) assembly
(7) return to final test.

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ENGINEERING NOTES

EMPLOYEE ____________ DATE ____________ PAGE NO. ____________

RCC ____________ SUBJECT ____________

FINAL ASSEMBLY

Manpower

1shift 28 hrs overtime (last week of month)
(4hrs/day, 8hrs saturday)

15 total workers
(2) wg 10's
(13) Wg 9's ⇒ usually 5 of those are in balance

Time to build a GTE (Sonora)

Subassembly's:

397 – 18 hrs ± 1 hr
180 – 23 hrs ± 4hr

Final assembly: (Hunt)

397 – 8 hr ± 1 hr
180 – 7hrs ± 1 hr

Interviews: 397 – 26 ± 2hrs
180 – 30 ± 5hrs

Standards: 397 – 30.78 hrs (E)
180 – 38.54 hrs (E)

NOTES: Can build up to 4 engines at one time
all operations can be done by a
Wg 9 or Wg 10.

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ENGINEERING NOTES

EMPLOYEE ______________ DATE ____________ PAGE NO. __________

RCC ____________ SUBJECT ______________

FINAL TEST

MANPOWER:

14 total workers; (2) Wg 10's
(1) Wg 9
(1) Wg 7 } final enclosure (can't run tests)

(10) Wg 10's – testers

8 active test cells.

1 shift ⇒ apx 1week of overtime per month (end of month), (4hrs a day)

TEST TIMES:

a test takes apx 8 hr to install, run, remove

All tests consist of:
- installation – 2hrs (constant)
- test time (computer on time) – time varies
- removal – 2hr (constant)

– any test will be apx 4 hrs longer than the recorded computer run time (cell dwell time) Part of this time is idle time in some cases.

Standards:

	test	final prep
397 –	19.65 hrs (E)	3.48 (E)
180 –	21.30 hrs (E)	3.48 (E)

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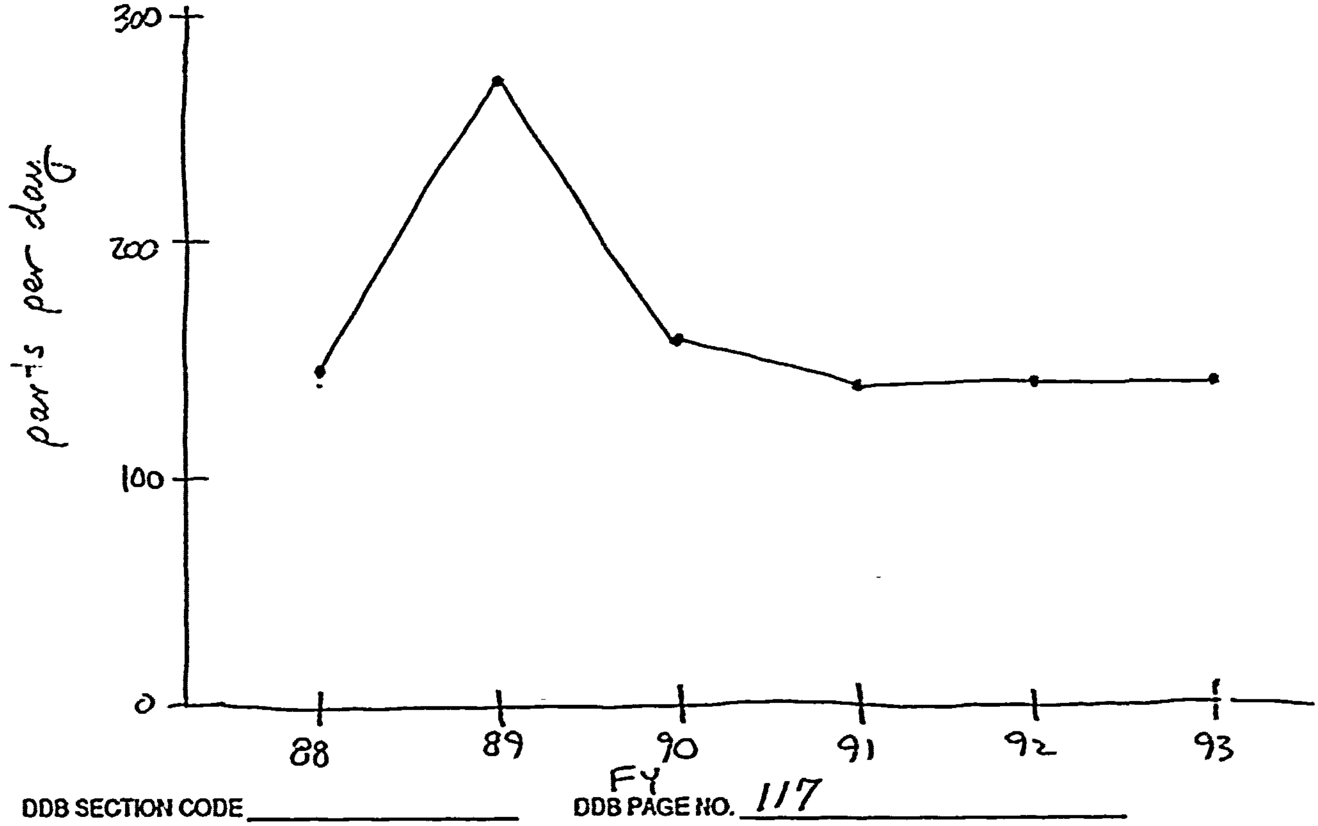
ENGINEERING NOTES

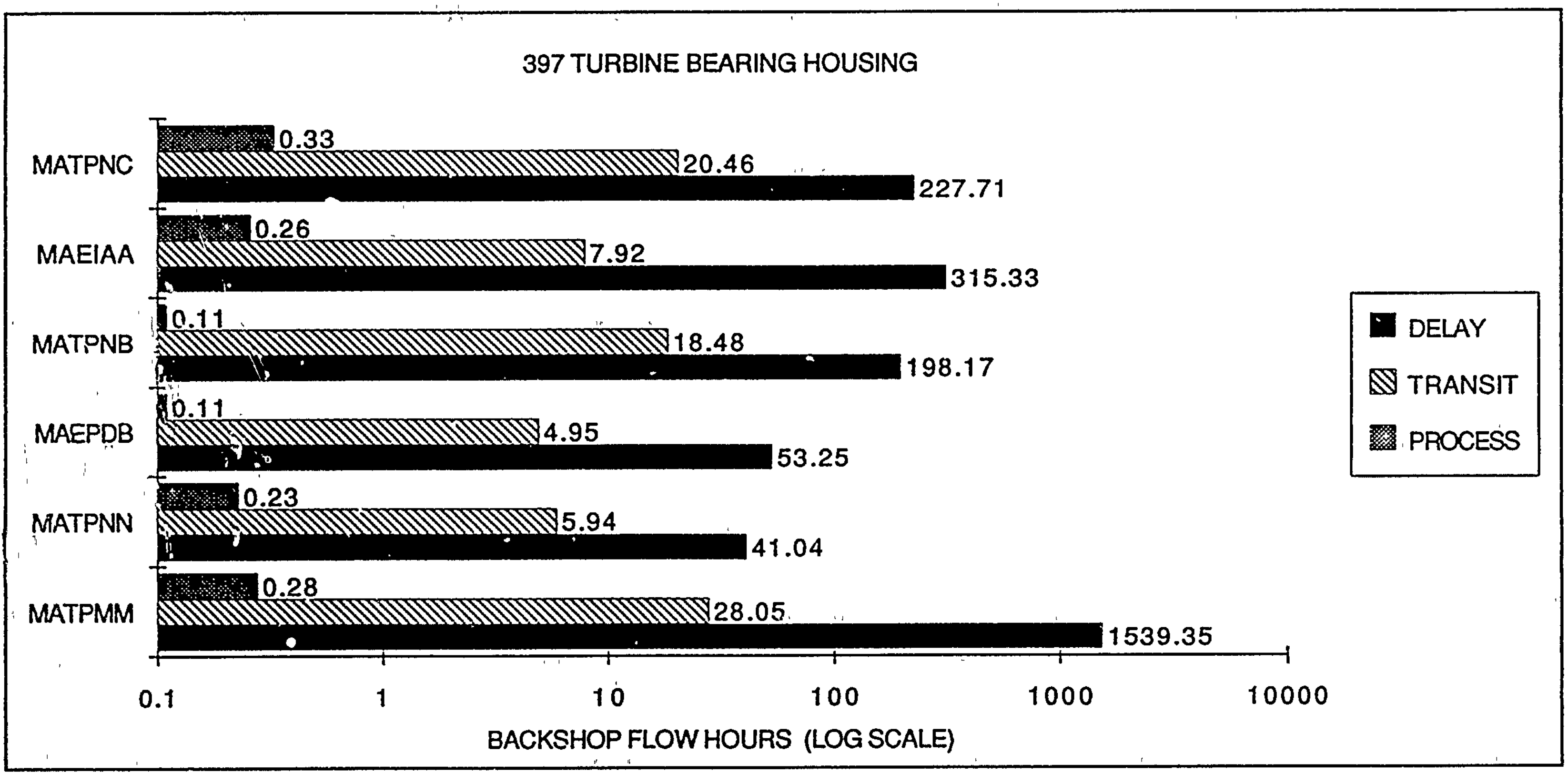
EMPLOYEE Premo DATE ______ PAGE NO. ______

RCC MATPS1 SUBJECT Projected FPI workload

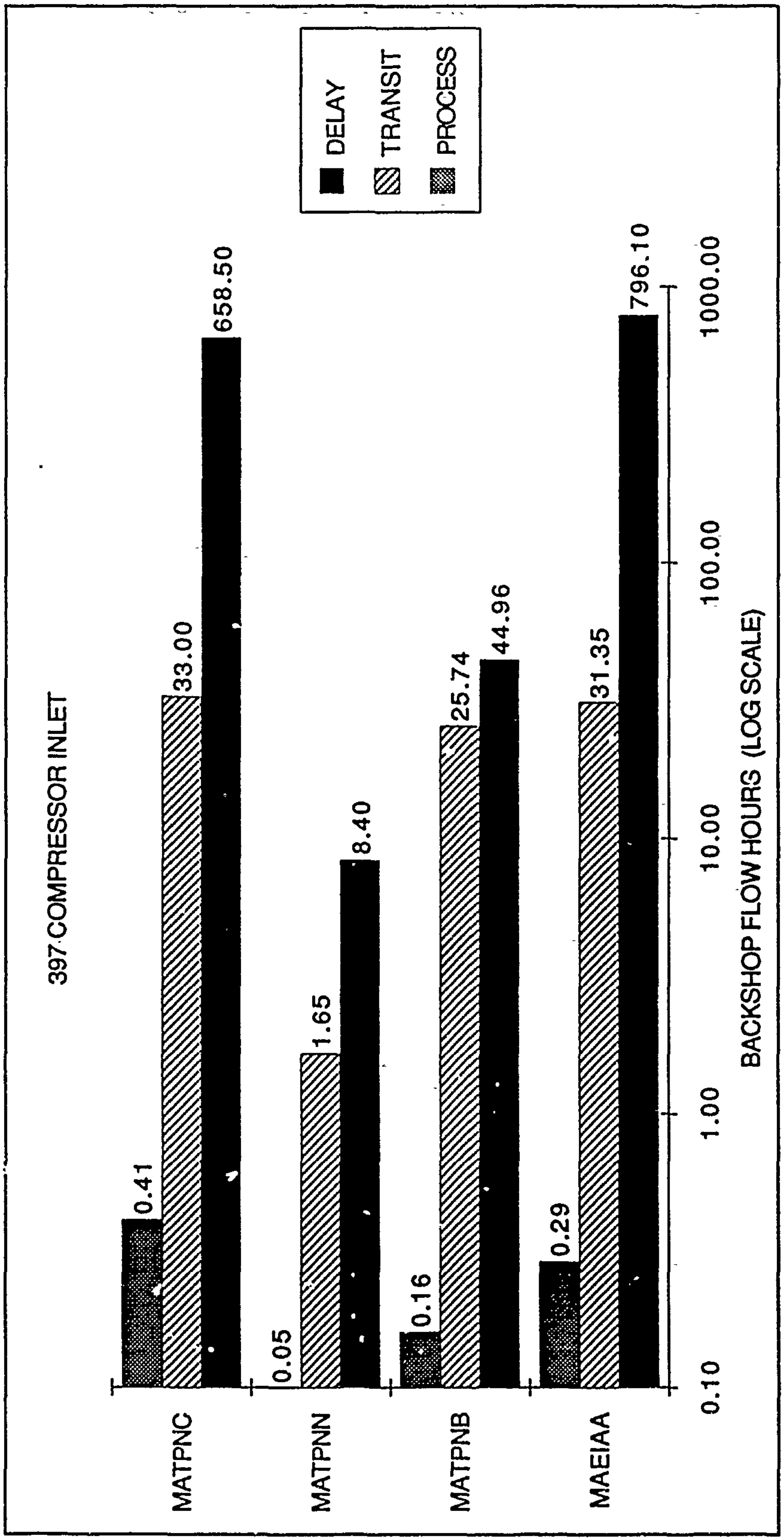
ASSET TYPE	approximate # of parts per FY					
	88	89	90	91	92	93
Starters	1719 × 8 = 13,752	3232 × 8 = 25,856	952 × 8 = 7,616	852 × 8 = 6816	852 × 8 = 6816	852 × 8 = 6816
GTE's	694 × 22 = 15,268	1174 × 22 = 25,828	835 × 22 = 18,370	800 × 22 = 17,600	800 × 22 = 17,600	800 × 22 = 17,600
F15, F16 systems	907 × 8 = 7,256	2075 × 8 = 16,600	1730 × 8 = 13,840	1280 × 8 = 10,240	1350 × 8 = 10,800	1350 × 8 = 10,800
TOTALS	36,276	68,284	39,826	34,656	35,216	35,216
parts/day (based on 250 days per year)	145	273	159	139	141	141

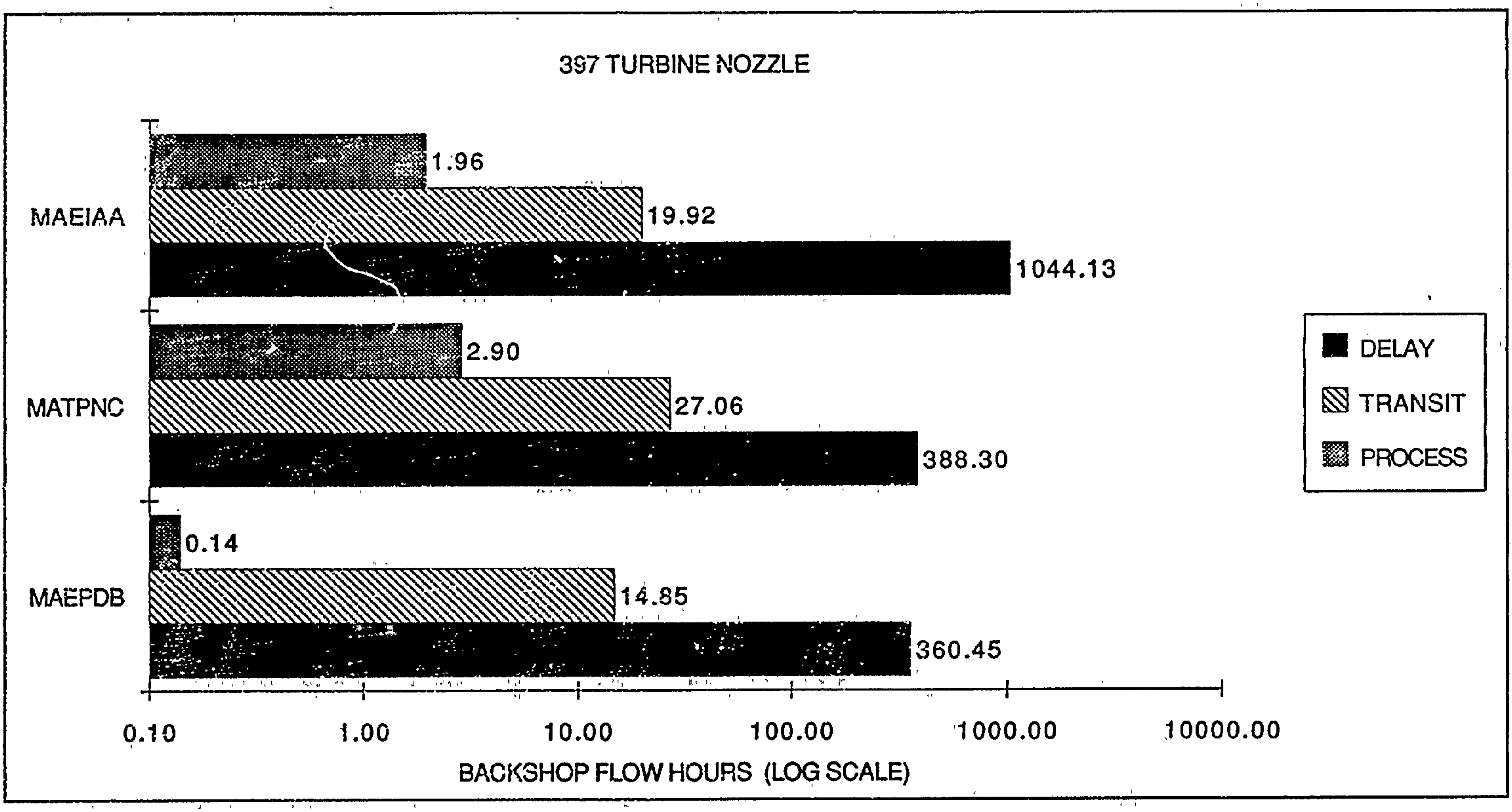


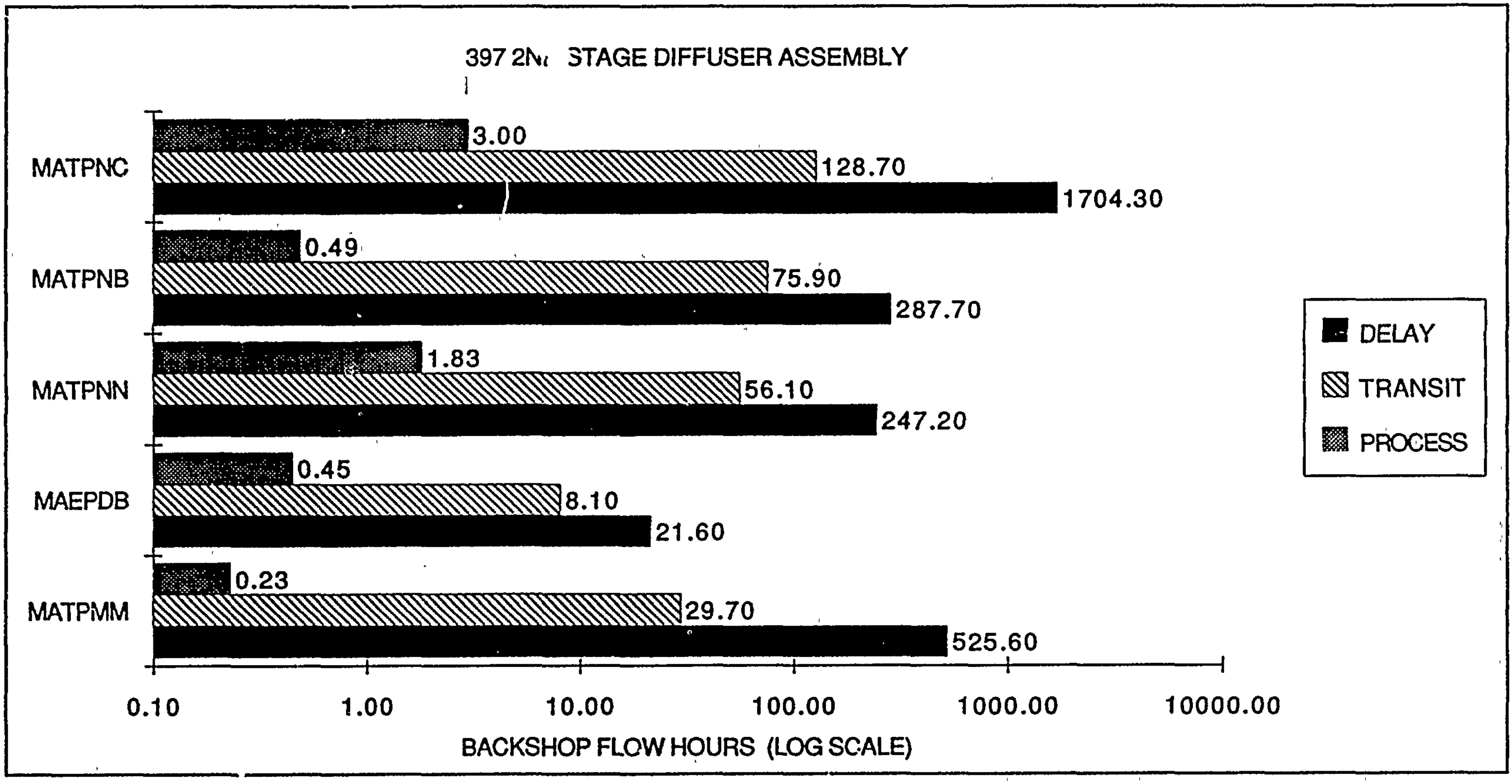
DDB SECTION CODE ______ DDB PAGE NO. 117

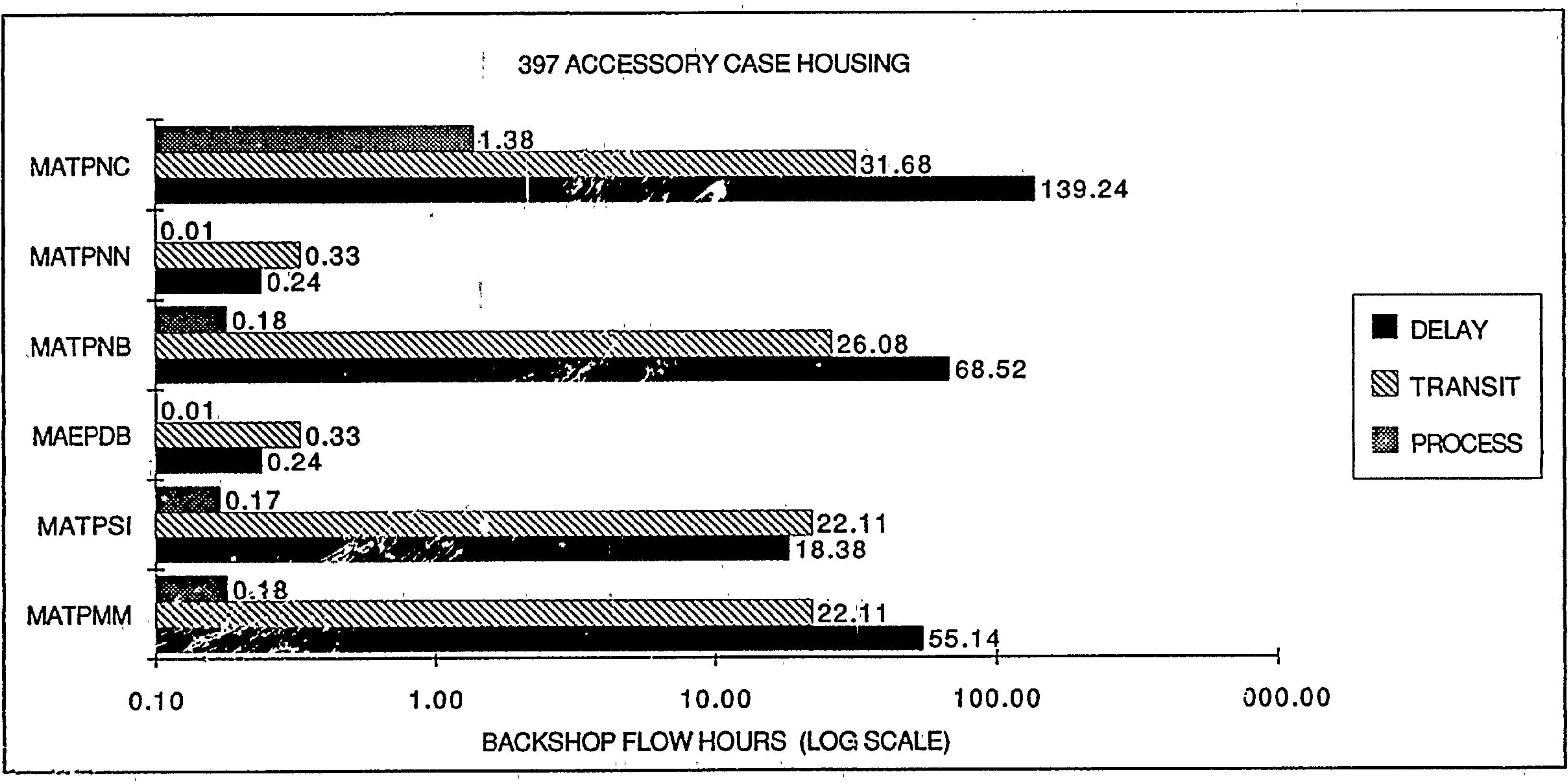


397 TURBINE BEARING HOUSING

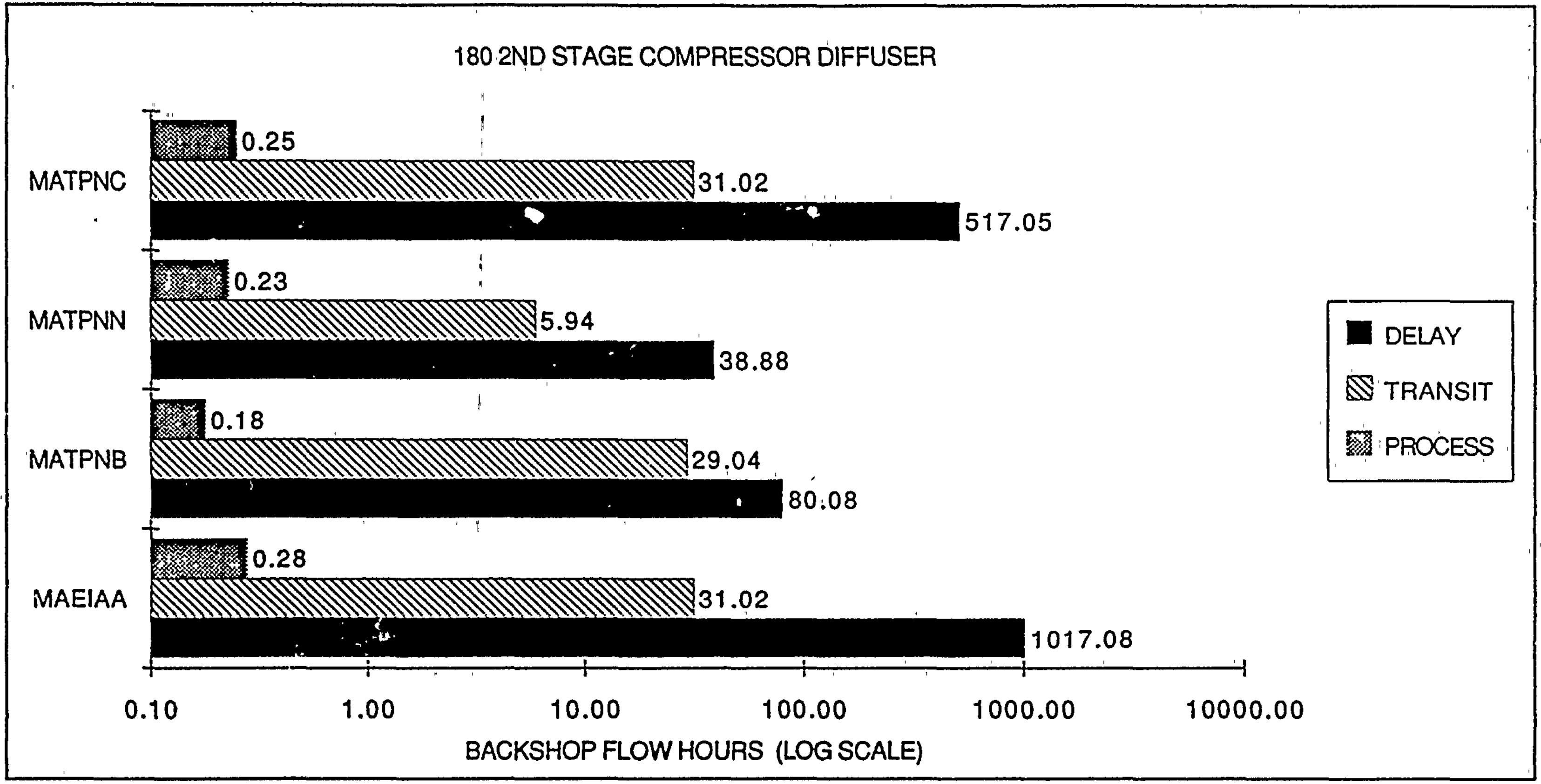

397 COMPRESSOR INLET
DELAY
TRANSIT
PROCESS
MATPNC
MATPNN
MATPNB
MAEIAA
0.41
33.00
658.50
0.05
1.65
8.40
0.16
25.74
44.96
0.29
31.35
796.10
0.10
1.00
10.00
100.00
1000.00
BACKSHOP FLOW HOURS (LOG SCALE)


397 TURBINE NOZZLE
MAEIAA
1.96
19.92
1044.13
MATPNC
2.90
27.06
388.30
MAEPDB
0.14
14.85
360.45
DELAY
TRANSIT
PROCESS
0.10
1.00
10.00
100.00
1000.00
10000.00
BACKSHOP FLOW HOURS (LOG SCALE)


397 2Nd STAGE DIFFUSER ASSEMBLY
MATPNC
3.00
128.70
1704.30
MATPNB
0.49
75.90
287.70
MATPNN
1.83
56.10
247.20
MAEPDB
0.45
8.10
21.60
MATPMM
0.23
29.70
525.60
0.10
1.00
10.00
100.00
1000.00
10000.00
BACKSHOP FLOW HOURS (LOG SCALE)
DELAY
TRANSIT
PROCESS

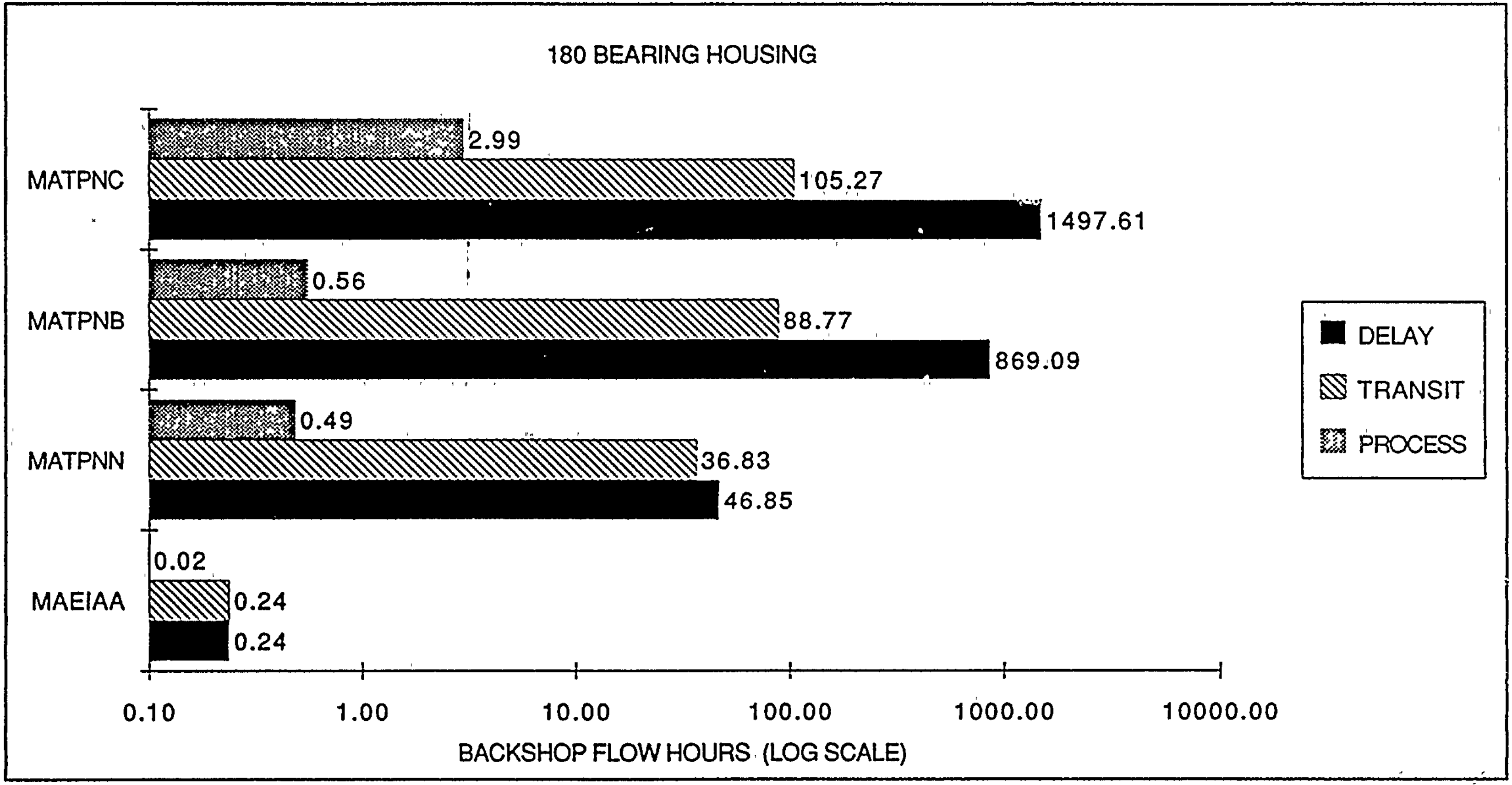


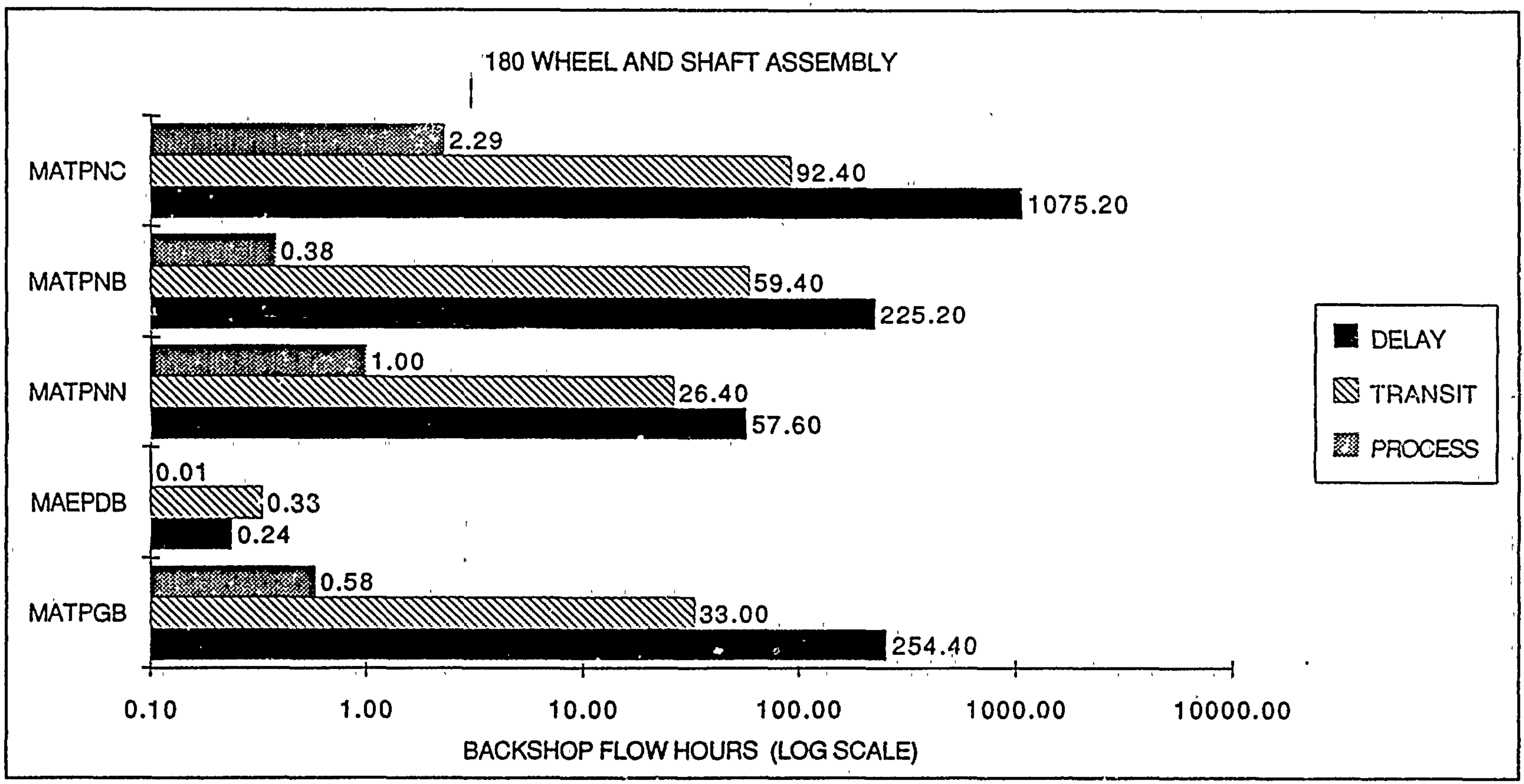
397 ACCESSORY CASE HOUSING

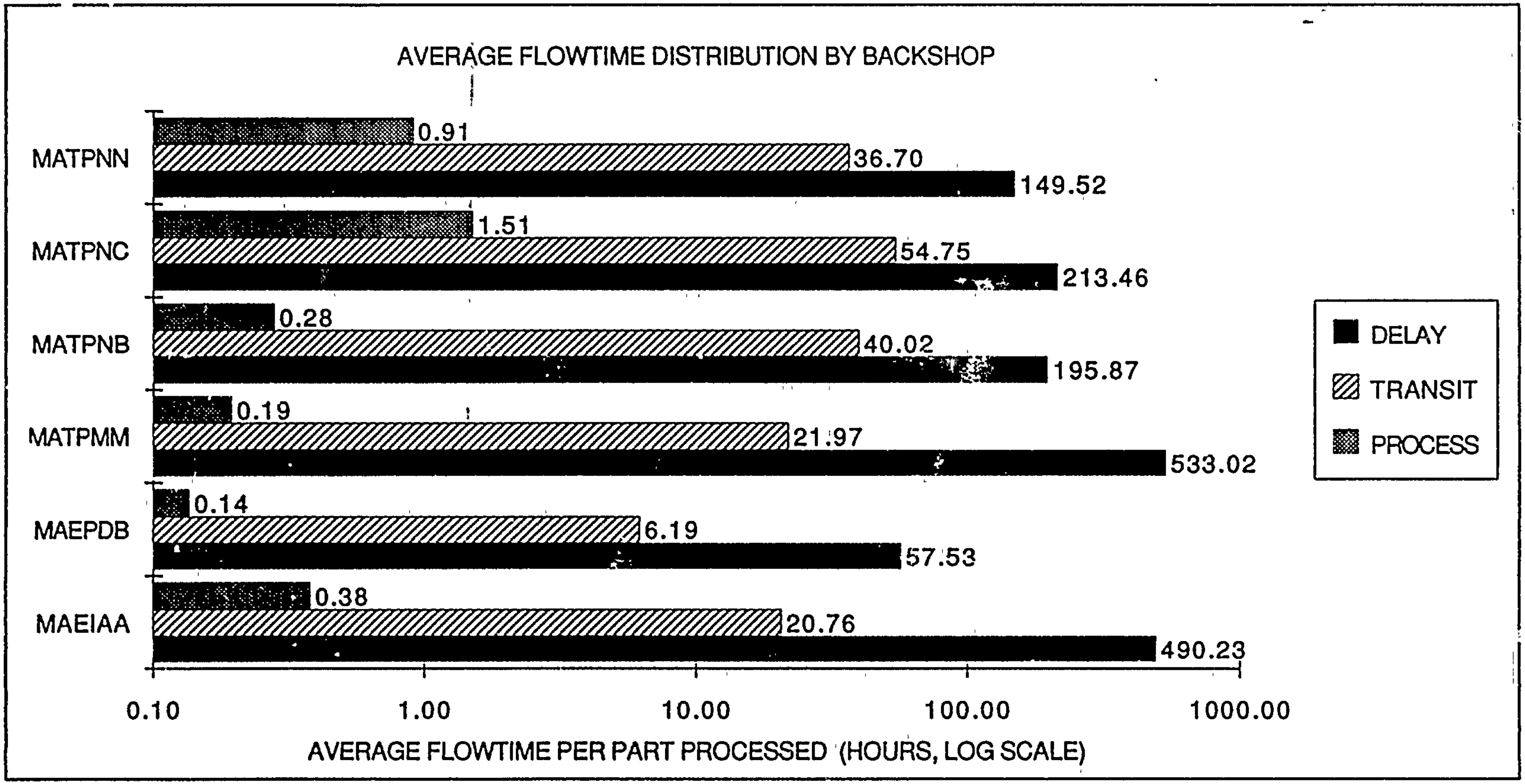


180 2ND STAGE COMPRESSOR DIFFUSER

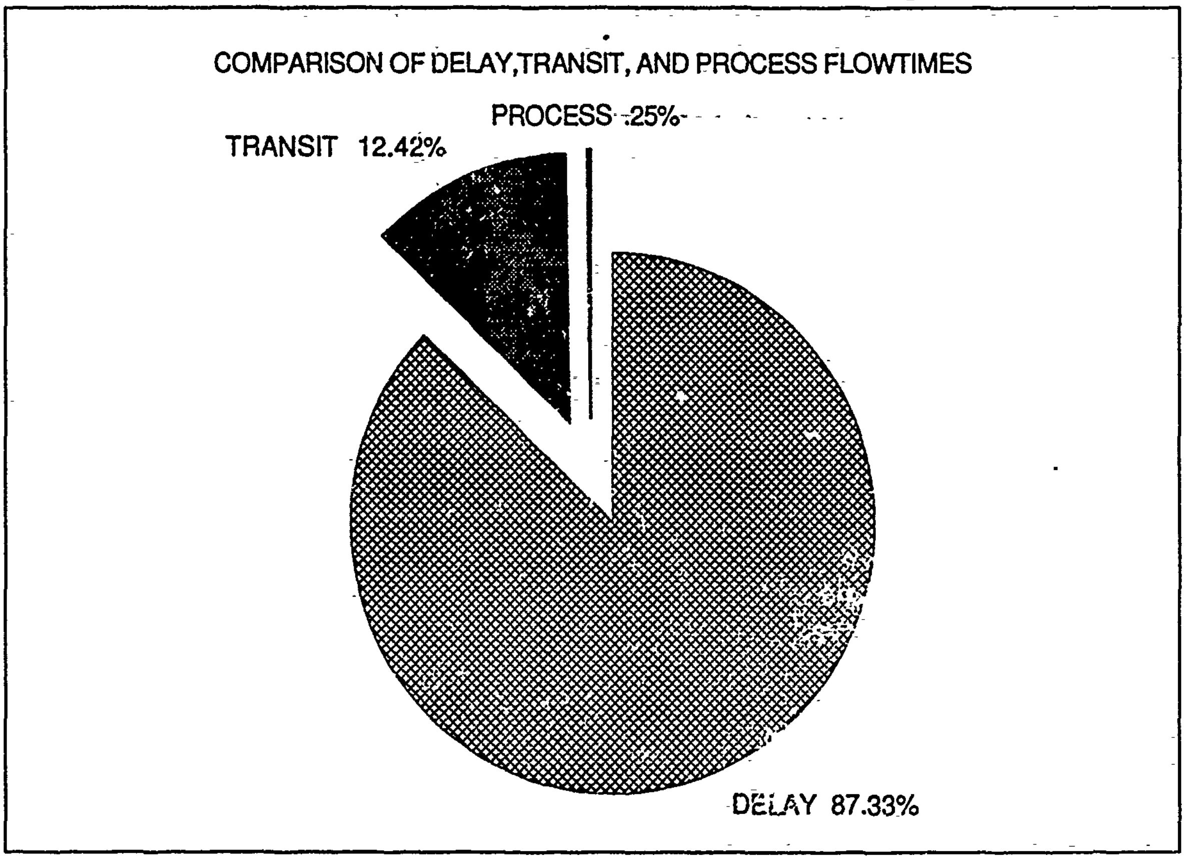
134

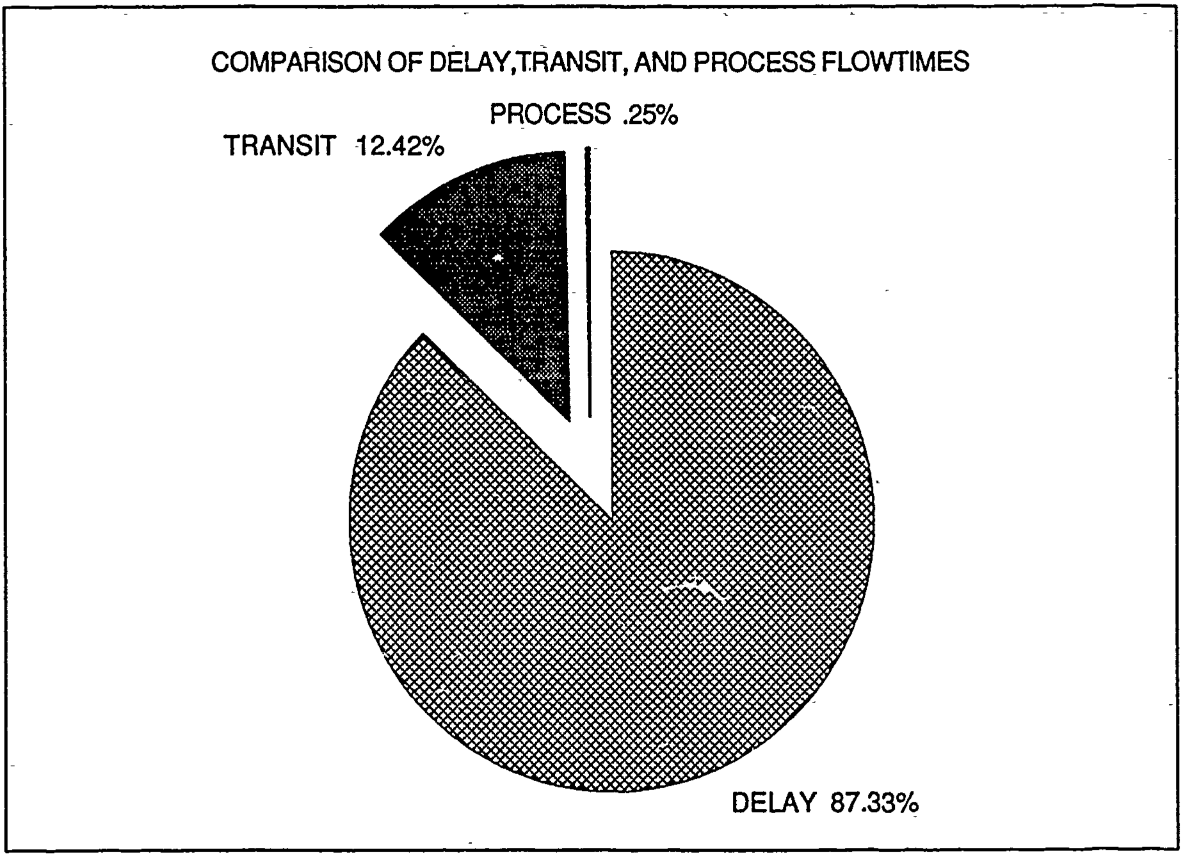

180 BEARING HOUSING


180 WHEEL AND SHAFT ASSEMBLY
MATPNC
2.29
92.40
1075.20
MATPNB
0.38
59.40
225.20
MATPNN
1.00
26.40
57.60
MAEPDB
0.01
0.33
0.24
MATPGB
0.58
33.00
254.40
0.10
1.00
10.00
100.00
1000.00
10000.00
BACKSHOP FLOW HOURS (LOG SCALE)
DELAY
TRANSIT
PROCESS



AVERAGE FLOWTIME DISTRIBUTION BY BACKSHOP


COMPARISON OF DELAY,TRANSIT, AND PROCESS FLOWTIMES
PROCESS .25%
TRANSIT 12.42%
DELAY 87.33%


COMPARISON OF DELAY,TRANSIT, AND PROCESS FLOWTIMES
PROCESS .25%
TRANSIT 12.42%
DELAY 87.33%

BACKSHOP FLOWTIMES DATA

				MAEIAA
MAEIAA	0.24	0.24	0.02	MAEPDB
MAEIAA	266.66	22.11	0.25	MATPMM
MAEIAA	315.33	7.92	0.26	MATPNB
MAEIAA	323.76	23.43	0.13	MATPNC
MAEIAA	331.20	29.70	0.23	MATPNN
MAEIAA	395.78	25.42	0.23	
MAEIAA	412.00	16.50	0.10	
MAEIAA	796.10	31.35	0.29	
MAEIAA	1017.08	31.02	0.28	
MAEIAA	1044.13	19.92	1.96	MAEIAA
MAEPDB	0.24	0.33	0.01	
MAEPDB	0.24	0.33	0.01	
MAEPDB	11.28	4.44	0.25	
MAEPDB	13.20	16.50	0.11	
MAEPDB	21.60	8.10	0.45	
MAEPDB	53.25	4.95	0.11	
MAEPDB	360.45	14.85	0.14	MAEPDB
MATPGB	254.40	33.00	0.58	
MATPMM	12.00	8.00	0.08	
MATPMM	55.14	22.11	0.18	
MATPMM	525.60	29.70	0.23	
MATPMM	1539.35	28.05	0.28	MATPMM
MATPNB	24.48	8.94	0.11	
MATPNB	35.49	29.75	0.41	
MATPNB	44.96	25.74	0.16	
MATPNB	68.52	26.08	0.18	
MATPNB	80.08	29.04	0.18	
MATPNB	81.65	23.43	0.15	
MATPNB	137.01	44.88	0.29	
MATPNB	153.95	48.68	0.33	
MATPNB	198.17	18.48	0.11	
MATPNB	225.20	59.40	0.38	
MATPNB	228.24	53.13	0.34	
MATPNB	287.70	75.90	0.49	
MATPNB	307.70	28.03	0.18	
MATPNB	869.09	88.77	0.56	MATPNB
MATPNC	59.73	48.27	0.36	
MATPNC	139.24	31.68	1.33	
MATPNC	218.80	49.50	1.40	
MATPNC	227.71	20.46	0.33	
MATPNC	388.30	27.06	2.90	
MATPNC	405.56	61.38	0.34	
MATPNC	517.05	31.02	0.25	
MATPNC	658.50	33.00	0.41	
MATPNC	804.41	49.67	2.23	
MATPNC	953.26	25.41	1.62	

BACKSHOP FLOWTIMES DATA

MATPNC	1075.20	92.40	2.29	
MATPNC	1087.27	60.98	1.06	
MATPNC	1145.14	56.43	2.12	
MATPNC	1497.61	105.27	2.99	
MATPNC	1704.30	128.70	3.00	MATPNC
MATPNN	0.24	0.33	0.01	
MATPNN	8.40	1.65	0.05	
MATPNN	38.88	5.94	0.23	
MATPNN	41.04	5.94	0.23	
MATPNN	46.85	36.83	0.49	
MATPNN	57.60	26.40	1.00	
MATPNN	133.28	18.48	0.56	
MATPNN	247.20	56.10	1.83	
MATPNN	250.70	127.39	2.77	
MATPNN	274.20	112.20	2.74	
MATPNN	345.60	26.40	0.80	
MATPNN	350.22	22.77	0.18	MATPNN
MATPSI	18.38	22.11	0.17	
TOTALS BY BACKSHOP				
	DELAY	**TRANSIT**	**PROCESS**	
MAEIAA	4902.28	207.61	3.75	5113.64
MAEPDB	460.26	49.5	1.08	510.84
MATPMM	2132.09	87.86	0.77	2220.72
MATPNB	2742.24	560.25	3.87	3306.36
MATPNC	3201.91	821.23	22.68	4045.82
MATPNN	1794.21	440.43	10.89	2245.53
TOTAL	15232.99	2166.88	43.04	17442.91
% CONTRIBUTI	**DELAY**	**TRANSIT**	**PROCESS**	
MAEIAA	0.32	0.10	0.09	
MAEPDB	0.03	0.02	0.03	
MATPMM	0.14	0.04	0.02	
MATPNB	0.18	0.26	0.09	
MATPNC	0.21	0.38	0.53	
MATPNN	0.12	0.20	0.25	
	DELAY	**TRANSIT**	**PROCESS**	
TOTALS	15232.99	2166.88	43.04	
AVERAGE FLOWTIME PER PART PROCESSED				
	DELAY	**TRANSIT**	**PROCESS**	
MAEIAA	490.23	20.7[illegible]	0.38	
MAEPDB	57.53	6.19	0.14	
MATPMM	533.02	21.97	0.19	
MATPNB	195.87	40.02	0.28	
MATPNC	213.46	54.75	1.51	
MATPNN	149.52	36.70	0.91	

← chart is based on this data

BACKSHOP FLOWTIMES DATA

DELAY	TRANSIT	PROCESS
4902.28	207.61	3.75
460.26	49.5	1.08
2132.09	87.86	0.77
2742.24	560.25	3.87
3201.91	821.23	22.68
1794.21	440.43	10.89
4902.28	207.61	3.75
460.26	49.5	1.08
2132.09	87.86	0.77
2742.24	560.25	3.87

BACKSHOP FLOWTIMES DATA

3201.91	821.23	22.68
1794.21	440.43	10.89

397 BACKSHOP FLOWTIMES

	A	B	C	D	E
1	**TURBINE BEARING HOUSING**				
2		DELAY	TRANSIT	PROCESS	
3	MATPMM	1539.35	28.05	0.28	
4	MATPNN	41.04	5.94	0.23	
5	MAEPDB	53.25	4.95	0.11	
6	MATPNB	198.17	18.48	0.11	
7	MAEIAA	315.33	7.92	0.26	
8	MATPNC	227.71	20.46	0.33	
9	TOTALS	2374.85	85.8	1.32	2461.97
10					
11	**COMPRESSOR INLET**				
12		DELAY	TRANSIT	PROCESS	
13	MAEIAA	796.10	31.35	0.29	
14	MATPNB	44.96	25.74	0.16	
15	MATPNN	8.40	1.65	0.05	
16	MATPNC	658.50	33.00	0.41	
17	TOTALS	1507.96	91.74	0.91	1600.61
18					
19	**TURBINE NOZZLE**				
20		DELAY	TRANSIT	PROCESS	
21	MAEPDB	360.45	14.85	0.14	
22	MATPNC	388.30	27.06	2.90	
23	MAEIAA	1044.13	19.92	1.96	
24	TOTALS	1792.88	61.83	5	1859.71
25					
26	**2ND STAGE DIFFUSER ASSY.**				
27		DELAY	TRANSIT	PROCESS	
28	MATPMM	525.60	29.70	0.23	
29	MAEPDB	21.60	8.10	0.45	
30	MATPNN	247.20	56.10	1.83	
31	MATPNB	287.70	75.90	0.49	
32	MATPNC	1704.30	128.70	3.00	
33	TOTALS	2786.4	298.5	6	3090.9
34					
35	**ACCESSORY CASE HOUSING**				
36		DELAY	TRANSIT	PROCESS	
37	MATPMM	55.14	22.11	0.18	
38	MATPSI	18.38	22.11	0.17	
39	MAEPDB	0.24	0.33	0.01	
40	MATPNB	68.52	26.08	0.18	
41	MATPNN	0.24	0.33	0.01	
42	MATPNC	139.24	31.68	1.38	
43	TOTALS	281.76	102.64	1.93	386.33

180 BACKSHOP FLOWTIMES

COMBUSTION CHAMBER LINER				
	DELAY	TRANSIT	PROCESS	
MAEPDB	11.28	4.44	0.25	
MATPNB	35.49	29.75	0.41	
MATPNC	59.73	48.27	0.36	
MATPNN	250.70	127.39	2.77	
TOTALS	357.20	209.85	3.79	570.84
TURBINE TORUS				
	DELAY	TRANSIT	PROCESS	
MAEPDB	13.20	16.50	0.11	
MATPNB	153.95	48.68	0.33	
MATPNC	218.80	49.50	1.40	
MATPNN	274.20	112.20	2.74	
TOTALS	660.15	226.88	4.58	891.61
TURBINE NOZZLE				
	DELAY	TRANSIT	PROCESS	
MATPNB	307.70	28.03	0.18	
MATPNC	953.26	25.41	1.62	
MAEIAA	395.78	25.42	0.23	
TOTALS	1656.74	78.86	2.03	1737.63
2ND STAGE COMPRESSOR HOUSING				
	DELAY	TRANSIT	PROCESS	
MATPNN	345.60	26.40	0.80	
MAEIAA	331.20	29.70	0.23	
MATPNB	228.24	53.13	0.34	
MATPNC	1145.14	56.43	2.12	
TOTALS	2050.18	165.66	3.49	2219.33
1ST STAGE INLET ASSEMBLY				
	DELAY	TRANSIT	PROCESS	
MATPNN	133.28	18.48	0.56	
MAEIAA	266.66	22.11	0.25	
MATPNB	137.01	44.88	0.29	
MATPNC	804.41	49.67	2.23	
TOTALS	1341.36	135.14	3.33	1479.83
1ST STAGE COMPRESSOR DIFFUSER				
	DELAY	TRANSIT	PROCESS	
MAEIAA	323.76	23.43	0.13	
MATPNB	81.65	23.43	0.15	
MATPNC	405.56	61.38	0.34	
TOTALS	810.97	108.24	0.62	919.83

180 BACKSHOP FLOWTIMES

2ND STAGE DIFFUSER HOUSING				
	DELAY	TRANSIT	PROCESS	
MATPMM	12.00	8.00	0.08	
MATPNB	24.48	8.94	0.11	
MATPNN	350.22	22.77	0.18	
MAEIAA	412.00	16.50	0.10	
MATPNC	1087.27	60.98	1.06	
TOTALS	1885.97	117.19	1.53	2004.69
2ND STAGE COMPRESSOR DIFFUSER				
	DELAY	TRANSIT	PROCESS	
MAEIAA	1017.08	31.02	0.28	
MATPNB	80.08	29.04	0.18	
MATPNN	38.88	5.94	0.23	
MATPNC	517.05	31.02	0.25	
TOTALS	1653.09	97.02	0.94	1751.05
BEARING HOUSING				
	DELAY	TRANSIT	PROCESS	
MAEIAA	0.24	0.24	0.02	
MATPNN	46.85	36.83	0.49	
MATPNB	869.09	88.77	0.56	
MATPNC	1497.61	105.27	2.99	
TOTALS	2413.79	231.11	4.06	2648.96
WHEEL AND SHAFT ASSEMBLY				
	DELAY	TRANSIT	PROCESS	
MATPGB	254.40	33.00	0.58	
MAEPDB	0.24	0.33	0.01	
MATPNN	57.60	26.40	1.00	
MATPNB	225.20	59.40	0.38	
MATPNC	1075.20	92.40	2.29	
TOTALS	1612.64	211.53	4.26	1828.43

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ENGINEERING NOTES

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RCC

SUBJECT 397 flow

397 TURBINE BEARING 4SG

	PNC	MAEIAA	PNB	MAEPDB	PNN	PMM
delay	227.71	315.33	198.17	53.25	41.04	1539.35
process	.33	.26	.11	.11	.23	.28
transit	20.46	7.92	18.48	4.95	5.94	28.05
	248.50	323.51	216.76	58.31	47.21	1567.68

2461.97

	process	transit	delay	
MAEIAA	.29	31.35	796.10	Compressor inlet
PIIC	.16	25.74	44.96	
PNN	.05	1.65	8.40	
PNC	.41	33.00	658.50	
MAEPDB	.14	14.85	360.95	[illegible] 2
MATPNC	2.90	27.06	388.30	
MAEIAA	1.96	19.92	1044.13	
MATPMM	.23	29.70	525.60	end & diff assy.
MAEPDB	.45	8.10	21.60	
MATPNN	1.83	56.10	247.20	
NB	.49	75.90	287.70	
NC	3.00	128.70	1704.30	
MATPMM	.18	22.11	55.14	ACCESSORY CASE
PSI	.17	22.11	18.38	
MAEPDB	.01	.33	.24	
MATPNB	.18	26.08	68.52	
PNN	.00	.33	.24	
PNC	1.38	31.68	139.24	

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ENGINEERING NOTES

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DATE
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RCC ALL
SUBJECT 180 FLOW

	DELAY	TRANSIT	PROCESS	
MAEPDB	11.28	4.44	.25	combustion chamber Liner
MATPNB	35.49	29.75	.41	
MATPNC	59.73	48.27	.36	
MATPNN	250.70	127.39	2.77	
MAEPDB	13.20	16.50	.11	Turbine torus
MATPNB	153.95	48.68	.33	
MATPNC	218.80	49.50	1.40	
MATPNN	274.20	112.20	2.74	
MATPNB	307.70	28.03	.18	Turbine nozzle
MATPNC	953.26	25.41	1.62	
MAEIAA	395.78	25.41	.23	
MATPNN	345.60	26.40	.80	2nd stg comp hsg
MAEIAA	331.20	29.70	.23	
MATPNB	228.24	53.13	.34	
MAT PNC	1,145.14	56.43	2.12	
MATPNN	133.28	18.48	.56	1st stg inlet assy.
MAEIAA	266.66	22.11	.25	
MATPNB	137.01	44.88	.29	
MATPNC	804.41	49.67	2.23	
MAEIAA	323.76	23.43	.13	1st stg compressor diff.
MATPNB	81.65	23.43	.15	
MATPNC	405.56	61.38	.34	
MATPMM	12.00	8.00	.08	2nd stg diff housing
MATPNB	24.48	8.94	.11	
MATPNN	350.22	22.77	.18	
MAEIAA	412.00	16.50	.10	
MATPNC	1087.27	60.98	1.06	
MAEIAA	1017.08	31.02	.28	2nd stg comp diffuser
MATPNB	30.98	29.04	.18	
MATPNN	33.33	5.94	.23	
MATPNC	517.05	31.02	.25	

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ENGINEERING NOTES

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RCC F.C SUBJECT '30 FLOW

	Delay	Transit	Process	
MAEIAA	.24	.24	.02	Bearing housing
MATPNN	46.85	36.83	.49	
MATPNB	869.09	88.77	.56	
MATPNC	1497.61	105.27	2.99	
MATPGB	254.40	33.00	.58	wheel + shaft assembly
MAEPDB	.24	.33	.01	
MATPNN	57.60	26.40	1.00	
MATPNB	225.20	59.40	.38	
MATPNC	1075.20	92.40	2.29	

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180 STAT SUMMARY

	1ST STG COMP DIFFUSER		
RCC	CF	DAYS	HOURS
NC	0.875	10.375	249
NB	0.625	4.25	102
MAEIAA	0.625	13.125	315
NC	0.75	7.625	183
TOTAL		35.375	849
	1ST STG INLET ASSY		
RCC	CF	DAYS	HOURS
NC	0.83	23.17	556.00
NB	0.61	2.67	64.00
MAEIAA	0.67	12.39	297.33
NN	0.56	6.61	158.67
NC	0.67	13.33	320.00
NB	0.06	0.17	4.00
NC	0.06	0.06	1.33
NB	0.72	5.61	134.67
TOTAL		64.00	1536.00
	2ND STG COMP HSG		
RCC	CF	DAYS	HOURS
NC	0.92	13.92	334.15
NB	0.62	7.08	169.85
MAEIAA	0.69	12.00	288.00
NN	0.62	12.31	295.38
NC	0.54	23.00	552.00
NB	0.00		
NC	0.00		
NB	0.77	5.92	142.15
TOTAL		74.23	1781.54
	2ND STG DIFFUSER HSG		
RCC	CF	DAYS	HOURS
NC	0.83	36.00	864.00
MAEIAA	0.50	18.17	436.00
NN	0.67	15.83	380.00
NC	0.33	10.00	240.00
NB	0.00		
NN	0.00		
NC	0.17	1.17	28.00
NB	0.00		
NN	0.00		
NC	0.00		
NB	0.50	1.50	36.00
NC	0.50	2.00	48.00
MM	0.33	1.17	28.00
TOTAL		85.83	2060.00
	2ND STG COMP DIFFUSER		
RCC	CF	DAYS	HOURS
NC	0.56	18.89	453.33
NN	0.22	5.72	137.33
NC	0.44	20.56	493.33
NB	0.83	4.83	116.00
IAA	0.89	41.83	1004.00
TOTAL		91.83	2204.00

180 STAT SUMMARY

	BEARING HOUSING		
RCC	CF	DAYS	HOURS
NC	0.52	13.32	319.68
NB	0.04	0.36	8.64
NC	0.28	29.24	701.76
NB	0.76	10.48	251.52
NN	0.72	2.32	55.68
NC	0.72	4.08	97.92
NB	0.72	3.76	90.24
NC	0.68	19.36	464.64
EIAA	0.00		
NC	0.68	5.80	139.20
NN	0.12	0.00	
NC	0.16	3.76	90.24
NB	0.64	6.80	163.20
NN	0.60	0.92	22.08
NC	0.20	6.52	156.48
NB	0.52	18.68	448.32
TOTAL		125.40	3009.60
	TURBINE NOZZLE		
RCC	CF	DAYS	HOURS
IAA	0.77	18.00	432.00
NC	0.77	41.23	989.54
NB	0.85	14.46	347.08
TOTAL		73.69	1768.62
	TURBINE TORUS		
RCC	CF	DAYS	HOURS
NN	0.68	2.36	56.64
NC	0.52	6.56	157.44
NB	0.08	0.12	2.88
NN	0.76	6.68	160.32
PDB	0.4	1.24	29.76
NN	0.72	0.6	14.4
NC	0.36	3.72	89.28
NN	0.16	1.64	39.36
NB	0.68	4.2	100.8
NC	0.44	6.12	146.88
NN	0.72	12.12	290.88
NB	0.64	3.84	92.16
TOTAL		49.2	1180.8
	WHEEL AND SHAFT ASSY		
RCC	CF	DAYS	HOURS
NC	0.86	21.71	521.14
NB	0.71	5.57	133.71
NN	0.71	36.86	884.57
NC	0.57	11.00	264.00
PDB	0.29	98.29	2358.86
NB	1.00	7.00	168.00
NC	1.00	9.43	226.29
TOTAL		189.86	4556.57

397 STAT SUMMARY

	1ST STG INLET HSG ASSY		
RCC	CF	DAYS	HOURS
NC	0.09	0.48	11.48
NN	0.04	0.39	9.39
NC	0.09	1.52	36.52
NB	0.13	0.57	13.57
MAEIAA	0.96	33.83	811.83
NC	0.78	23.48	563.48
NB	0.61	2.70	64.70
TOTAL		62.96	1510.96
	ACCESSORY CASE HSG		
RCC	CF	DAYS	HOURS
NC	0.74	5.78	138.78
NN	0.00		
NB	0.00		
PDB	0.00		
NC	0.00		
NB	0.04	0.09	2.09
NC	0.13	1.26	30.26
NB	0.70	3.91	93.91
SI	0.61	1.91	45.91
NN	0.61	3.30	79.30
TOTAL		16.26	390.26
	TURBINE BEARING HSG		
RCC	CF	DAYS	HOURS
NC	0.33	3.42	82.00
IAA	0.08	2.50	60.00
NC	0.08	1.33	32.00
NB	0.19	2.39	57.33
PDB	0.17	9.03	216.67
IAA	0.17	10.69	256.67
NN	0.17	1.92	46.00
NC	0.22	7.67	184.00
NB	0.36	7.08	170.00
MM	0.83	63.53	1524.67
TOTAL		109.56	2629.33
	TURBINE NOZZLE		
RCC	CF	DAYS	HOURS
IAA	0.20	10.50	252.00
NC	0.50	15.93	382.40
IAA	0.50	43.10	1034.40
PDB	0.47	15.83	380.00
NC	0.37	3.93	94.40
TOTAL		89.30	2143.20

NC 611.48
NN 9.39

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ENGINEERING NOTES

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RCC MATPGB SUBJECT Rework & time estimates

- Following is a summary of an interview with Raul R. Garcia in MATPGB final assembly. Mr. Garcia is an alternate to Bill Hunt who is the supervisor in final assembly.

- According to Mr. Garcia, a rejected engine is worked until it finally is accepted on the test cell.

- Rework is done in the final assembly area.

- there are currently 4 bays in the final assembly area. One of the bays is dedicated to the 180 and 397 engines. Up to 4 engines may be worked in this bay at one time. Usually there are no delays caused by lack of workspace.

- Final assembly mechanics perform all repairs.

- Mr. Garcia supplied estimates for the amount of time that is required to rework a rejected engine. Because there is a large degree of variability in the rework process (the cause of problems is highly variable) the time estimates were broken down into 3 main problem categories and into 3 main repair types. This breakdown made it easier for Mr. Garcia to come up with estimates. For the purposes of the simulation model the estimates were summed up and a weighted average taken in order to come up with one all encompassing number for each type. A summary of these calculations follows.

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ENGINEERING NOTES

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RCC MATPGB SUBJECT Rework and Rejects

REJECT RATE CALCULATION

- The test cell reject rate for the 180 and 397 was calculated using the database of test cell activity for FY90. The following method was used: The total number of accepted engines was counted. Of all the engines that were rejected a count was made of first time rejects, second time rejects, and so on. Reject rate was calculated by dividing the number of first time rejects by the total number of engines that were eventually accepted.

- A multiplication factor was calculated for use in the simulation model in order to encompass all multiple rejects into one neat factor. This was done simply by dividing the total number of times GTES rejected on the test stand by the total number of GTES that produced the failures.

- The reject rate for the 180 and 397 GTE ended up to be the same at 24%.

- The rough calculations used for the analysis follow this page

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ENGINEERING NOTES

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RCC MATPGB

SUBJECT Rework calculation:

	180	397
TOTAL ACCEPTED	236	139
PASS FIRST ATTEMPT	180	106
FAIL FIRST ATTEMPT	56	33
FAIL SECOND ATTEMPT	17	11
FAIL THIRD ATTEMPT	5	1
FAIL FOURTH ATTEMPT	1	0
FAIL FIFTH ATTEMPT	1	0
TOTAL FAILURES	80	45
REJECT RATE OF GTE'S BUILT	$\frac{56}{236} = .24$	$\frac{33}{139} = .24$
MULTIPLICATION FACTOR	$\frac{80}{56} = 1.43$	$\frac{45}{33} = 1.36$

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ENGINEERING NOTES

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RCC MATPGB SUBJECT Rework of test stand Rejects

Source: Raul Garcia

REWORK (ie: rejects)

- 1 mechanic (Wg 9 or 10) does the work
- Engines are reworked until they are fixed they are not sent back to dissassembly
- Rework times (apx):

397	12hr ± 2hrs
180	16 hr ± 2 hrs

- initial trouble shoot in test cell takes (1) Wg 9 apx 30 min ± 15 min
- trouble shooting in ship takes (1) Wg 9 in final assembly about 30 min ± 15 min

STEPS IN REWORK:

(1) initial trouble shoot in test cell
(2) moved to final assembly
(3) trouble shoot in final assembly area
(4) disassembly
(5) repair
(6) assembly
(7) return to final test.

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ENGINEERING NOTES

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RCC MATPGB SUBJECT Final Assembly

Final Assembly building 329

Following is a summary of an interview with Mr. R. Samora in the final assembly area of MAEPGB. Mr. Samora is a first line supervisor in charge of the build up of subassemblies of the GTE's.

- The 397 GTE consists of 3 major subassemblies. They are the accessory case, the turbine section, and the compressor section.
- The 180 GTE is built up in two sections. The turbine section and compressor section are built up as one subassembly and the accessory case is built up as a seperate subassembly.
- After the subassemblies are built up in Mr. Samoras area they are stored on shelves until they are needed for final assembly into a complete GTE.
- Mr. Samora feels that it takes a little longer to build up the subassemblies than is reflected in the standards because of poor quality parts
- Following is a summary of Mr. Samoras estimates of the time required to build the subassemblies:

	Accessory Case	Turbine Section	Compressor Section
397	5-6 hrs	4 hrs (constant)	9 hrs (constant)
180	5-6 hrs	14-22 hrs	

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ENGINEERING NOTES

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RCC MATPGB SUBJECT Final Assembly

- Mr. Samora complained of a problem with defective parts. Poor quality control of reworked parts is requiring the assemblers to dimensionally inspect the parts prior to assembly. This takes extra time and is only partially effective because of a lack of proper inspection equipment. Often a bad part is not found until a sub assembly is partially completed. This wastes a considerable amount of time. Sometimes a defective part is not found until an engine is complete and does not perform properly on the test stand. Mr. Samora supplied a log of defective parts that he had been keeping recently because the defect problem has been so acute lately.

- At the time of our interview Mr. Samora presented a current example of a defective part and the time that is wasted. He showed a 180 turbine wheel and shaft which had a diameter built up and reground. The reworked surface was ground oversize, thus causing an interference during assembly. The entire assembly had to be dis-assembled, thus wasting 6 hrs of time. The bad part had spent almost a month in the machine shop, yet was stamped off and routed onward with a gross dimensional error. According to Mr. Samora this type of problem is common.

OPINION:

The problem with defective parts is directly related to the lack of control and accountability inherent in the current repair process. As long as bad workmanship cannot be easily traced backward

ENGINEERING NOTES

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RCC MATPGB SUBJECT Final Assembly

to its source in a <u>timely</u> fashion it is unlikely that quality will improve. As a stop gap measure all repaired parts (critical ones) should be reinspected prior to re-assembly into GTE's. This inspection would ideally be done where it can be done most effectively, in MATPSI inspection. Of course, this increase in workload would have to be accompanied by increased manpower in MATPSI. Hopefully, once problem spots are identified and corrected this inspection point prior to assembly would not be needed. Each shop would then be responisible for assuring the quality of their workmanship.

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ENGINEERING NOTES

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RCC MATPGB
SUBJECT Summary of assembly estimates

FINAL ASSEMBLY

Manpower

1shift 28 hrs overtime (last week of month)
(4hrs/day, 8hrs saturday)

15 total workers
(2) wg 10's
(13) wg 9's ⇒ usually 5 of those are in balance

Time to build a GTE (Summary)

Subassembly's – Source: R. Samora

	time (est)
397 –	18 hrs ± 1hr
180 –	23 hrs ± 4hr

Final assembly – Source: Bill Hunt

	time (est)
397 –	8hr ± 1hr
180 –	7hrs ± 1hr

Interviews:
397 – 26 ± 2hrs
180 – 30 ± 5hrs

Standards:
397 – 30.78 hrs (E)
180 – 39.54 hrs (E)

NOTES: Can build up to 4 engines at one time
all operations can be done by a
Wg 9 or Wg 10.

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RCC MATPGB SUBJECT Final Test

- Final testing for the 180 and 397 GTE's is done in building 340. This building is directly across the street from building 329 where the GTE's are assembled.
- The supervisor in Final test is Mr. Vaquera (5-5734)
- Ernest Martinez supplied manpower, equipment, shift distribution, overtime, and test time information in an interview. This information is summarized on the following page. Mr. Martinez is a tester.
- Each test cell is equipted with a computer. Testing is completely automated and all test information is recorded to a data base. It is possible to run an engine in the manual mode.

It takes apx 2hrs to install a GTE in a test cell. After installation is complete the computer system is turned on and test cell time is logged from that point on ward until the computer is turned off prior to removal of the GTE. Removal takes about 2hrs. In addition to the total test cell time that is logged, the total computer run time is also recorded whenever the engine is run in automatic mode. Manual run time is not recorded by the computer.

- Test cell data is kept in a data base. Computer scientist John Valchar (5-4374) was kind enough to supply a printout of the test cell activity for the 180 and 397 GTE's over the last FY. This information was used to calculate test times, rejection rates and cell utilization;

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RCC MATPGB SUBJECT Final Test, Interview data

FINAL TEST, SUMMARY OF INTERVIEW DATA

MANPOWER: (Source: Ernest Martinez)

14 total workers;
(2) Wg 10's
(1) Wg 9 } final enclosure (can't run tests)
(1) Wg 7

(10) Wg 10's – testers

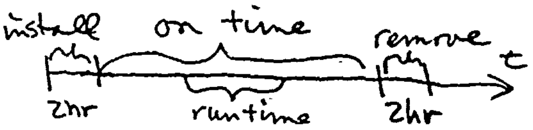
EQUIP: 8 active test cells, (one of these not used for GTE's)

SHIFTS: 1 shift ⇒ apx 1 week of overtime per month (end of month) (4 hrs/day)

TEST TIMES: (Source: Ernest Martinez)

a test takes apx 8 hr to install, run, remove

All tests consist of:
- installation – 2hrs (constant)
- cell time including run time (computer on time) – time varies
- removal – 2hr (constant)



- any test will be apx 4 hrs longer than the recorded computer run time (cell dwell time). Part of this time is idle time in some cases.

Standards:

	test	final prep
397 –	19.65 hrs (E)	3.48 (E)
180 –	21.30 hrs (E)	3.48 (E)

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RCC MATPGB SUBJECT Final Test

- Test cell data was entered into an excell database and sorted by test cell number, by cell time, and by accepted or rejected status.

- before entering it into the database the cell time data was corrected to account for the time which the GTE was in the test cell and there was no one to work on it. This was done because there is currently only one 8 hour shift per day but the cell time is logged continuously 24 hours a day.

- Averages and standard deviations were calculated for cell time and computer time for all tests, for tests which ended in rejection, and for tests which ended in accepting a GTE.

- Averages and standard deviations for cell time, cell count, and total cell time was computed for each individual test cell.

- Following is a summary of calculations and a copy of the data base used to obtain them:

- Histograms for cell times were produced with the help of Phil Parker and also follow.

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RCC MATPGB

SUBJECT FINAL TEST, CALCULATIONS

180

		CELL TIME	COMP. TIME
TOTAL:	AVERAGE	11.41	1.99
	STAND. DEV.	9.72	1.00
REJECTS:	AVERAGE	8.72	0.82
	STAND. DEV.	9.29	0.86
ACCEPTS:	AVERAGE	12.27	2.36
	STAND. DEV.	9.74	0.72

CELL #	COUNT	AVERAGE	STAND. DEV.	TOTAL TIME
5	21	16.60	13.36	348.57
6	36	10.95	6.78	394.37
7	20	10.78	9.11	215.57
8	14	9.71	6.19	135.93
9	27	10.06	11.09	271.60
10	20	13.81	10.88	276.25
11	42	9.87	9.26	414.47

397

		CELL TIME	COMP. TIME
TOTAL:	AVERAGE	9.83	2.20
	STAND. DEV.	8.31	1.08
REJECTS:	AVERAGE	8.24	0.80
	STAND. DEV.	9.13	0.93
ACCEPTS:	AVERAGE	10.36	2.66
	STAND. DEV.	7.96	0.63

CELL #.	COUNT	AVERAGE	STAND. DEV.	TOTAL TIME
5	29	11.78	10.50	341.75
6	58	10.26	7.72	595.15
7	20	11.80	9.76	235.92
8	61	7.69	5.35	469.33
9	68	9.07	6.71	616.77
10	31	12.30	11.13	381.40
11	47	9.47	9.58	445.20

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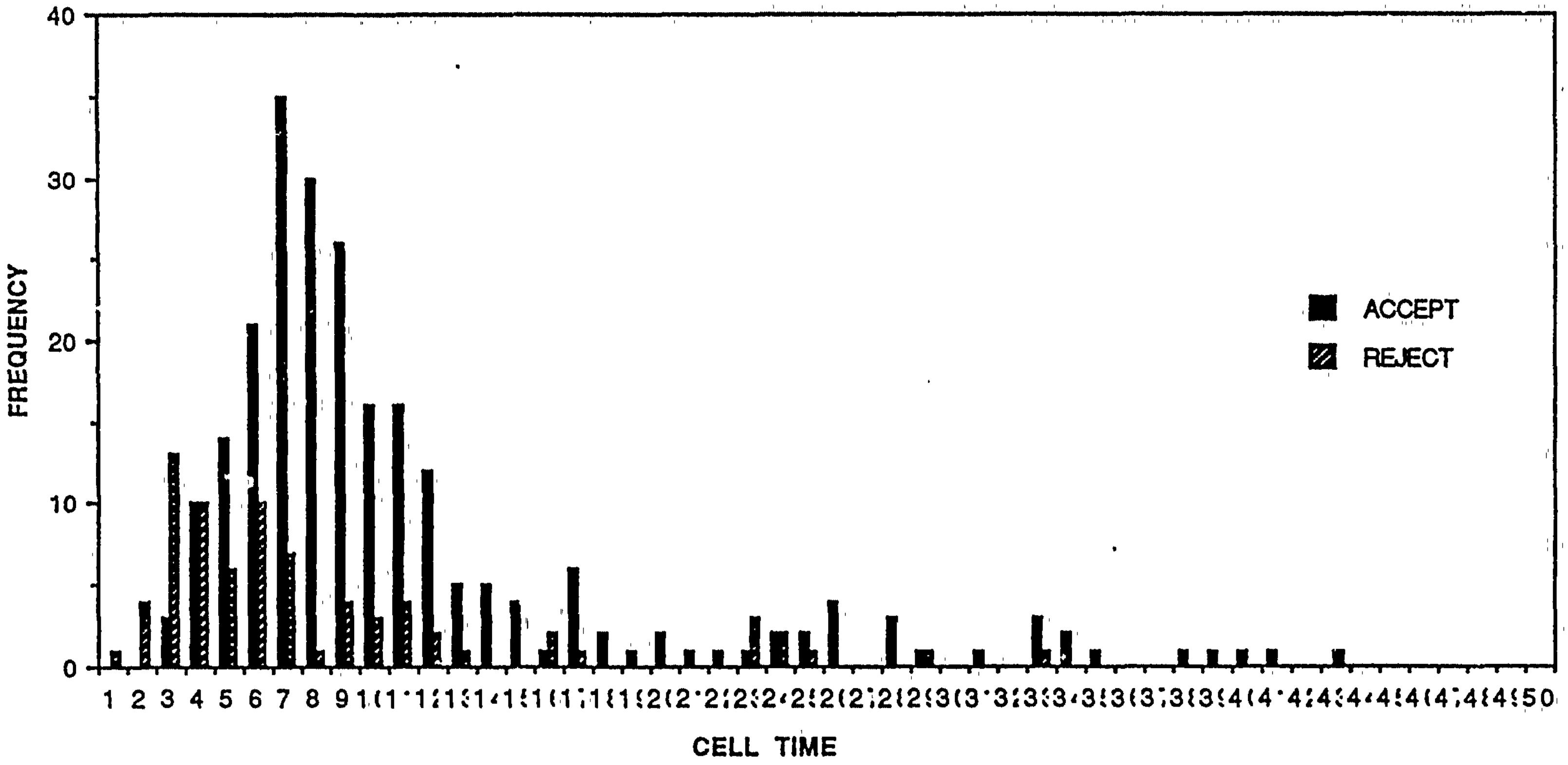
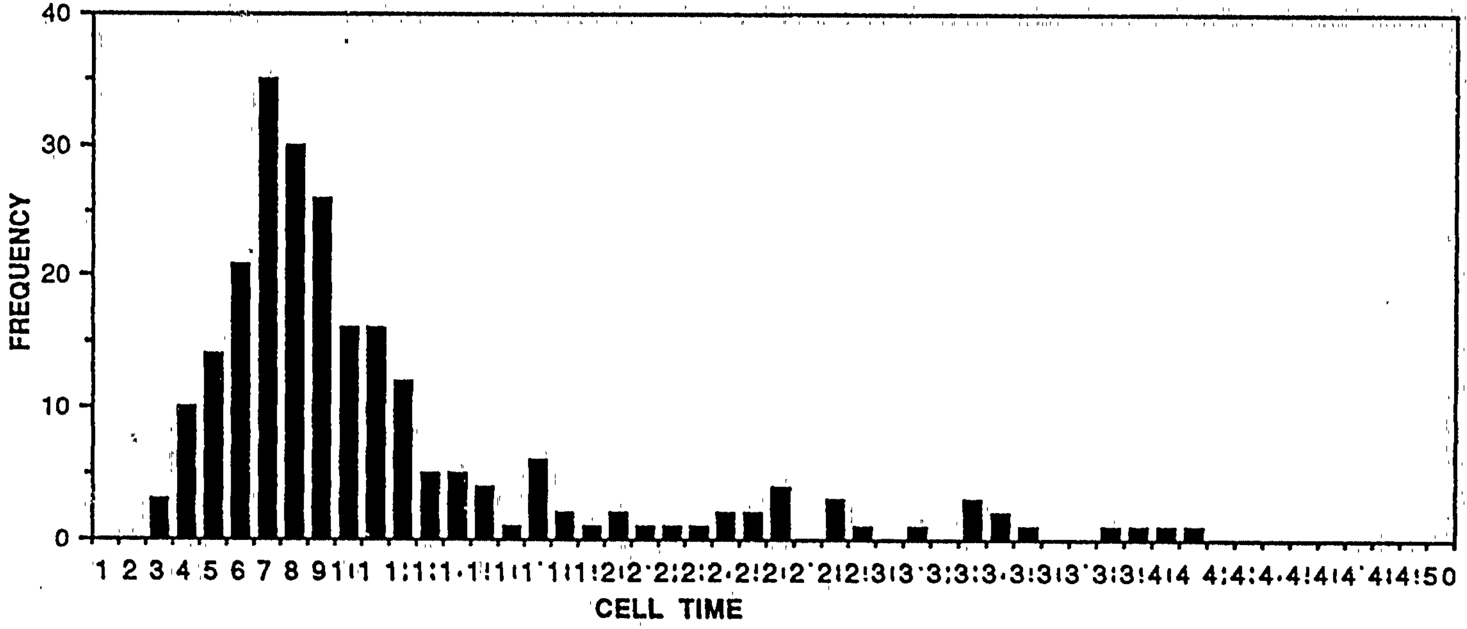
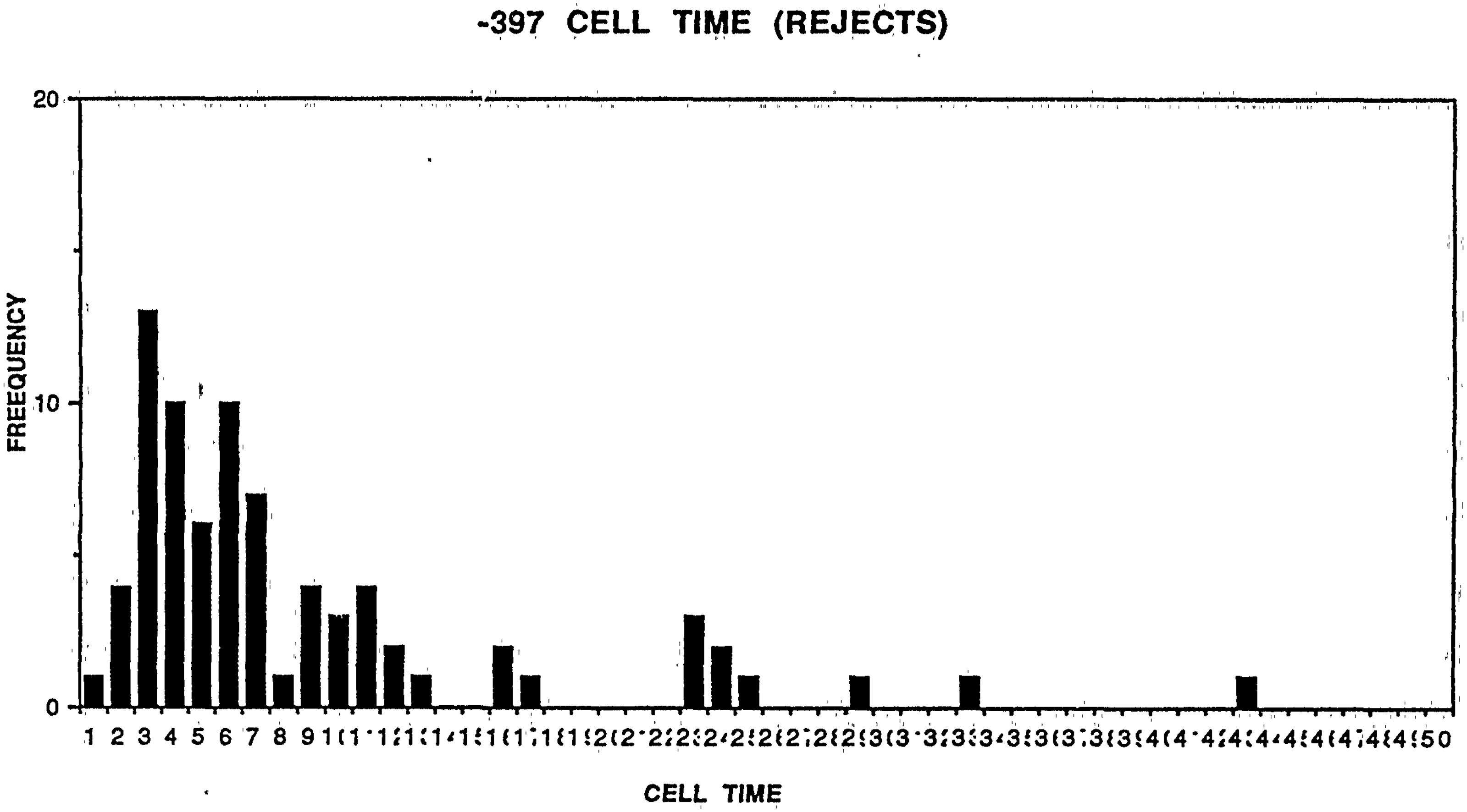
-392 CELL TIME (ACCEPTS VS REJECTS)



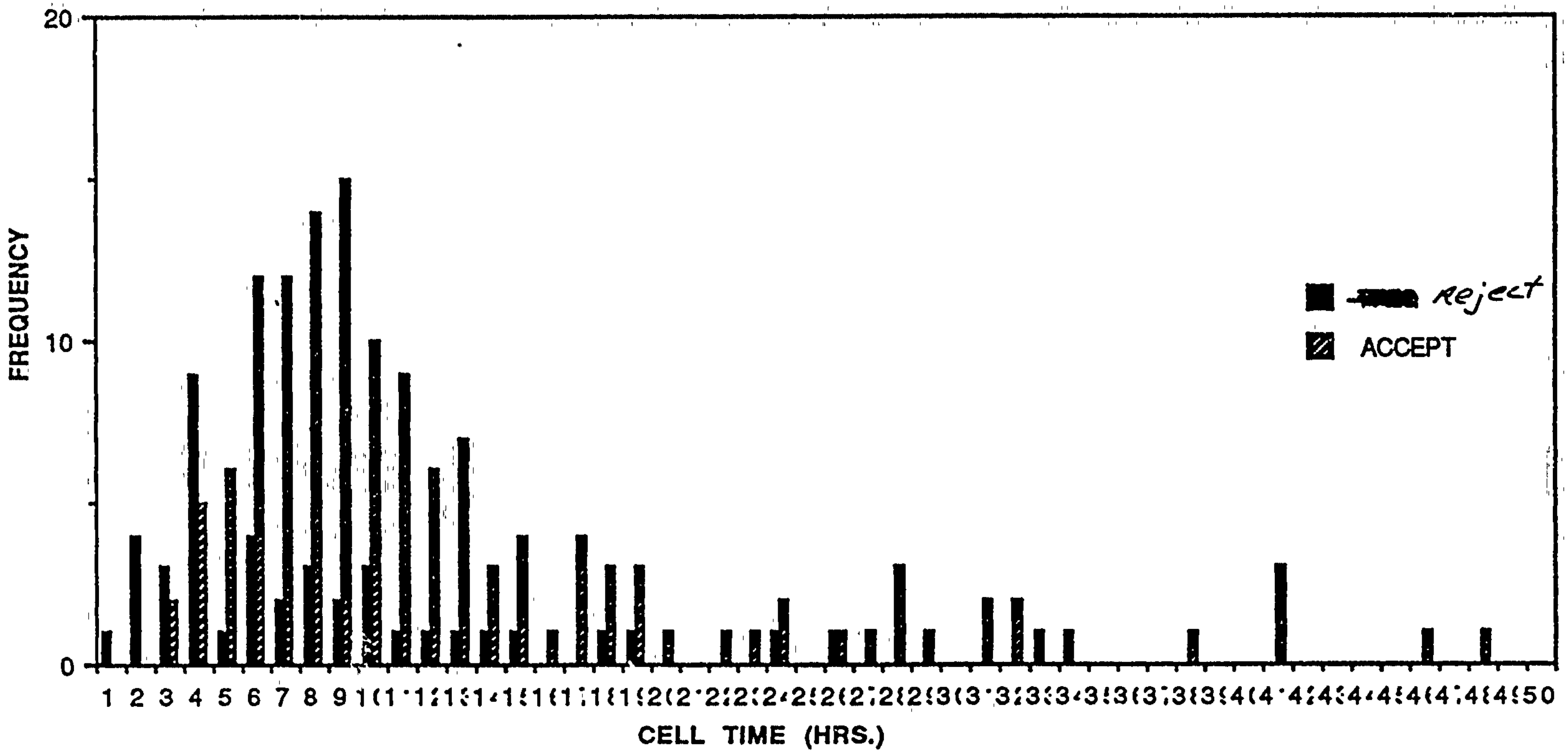
-397 CELL TIME (ACCEPT)



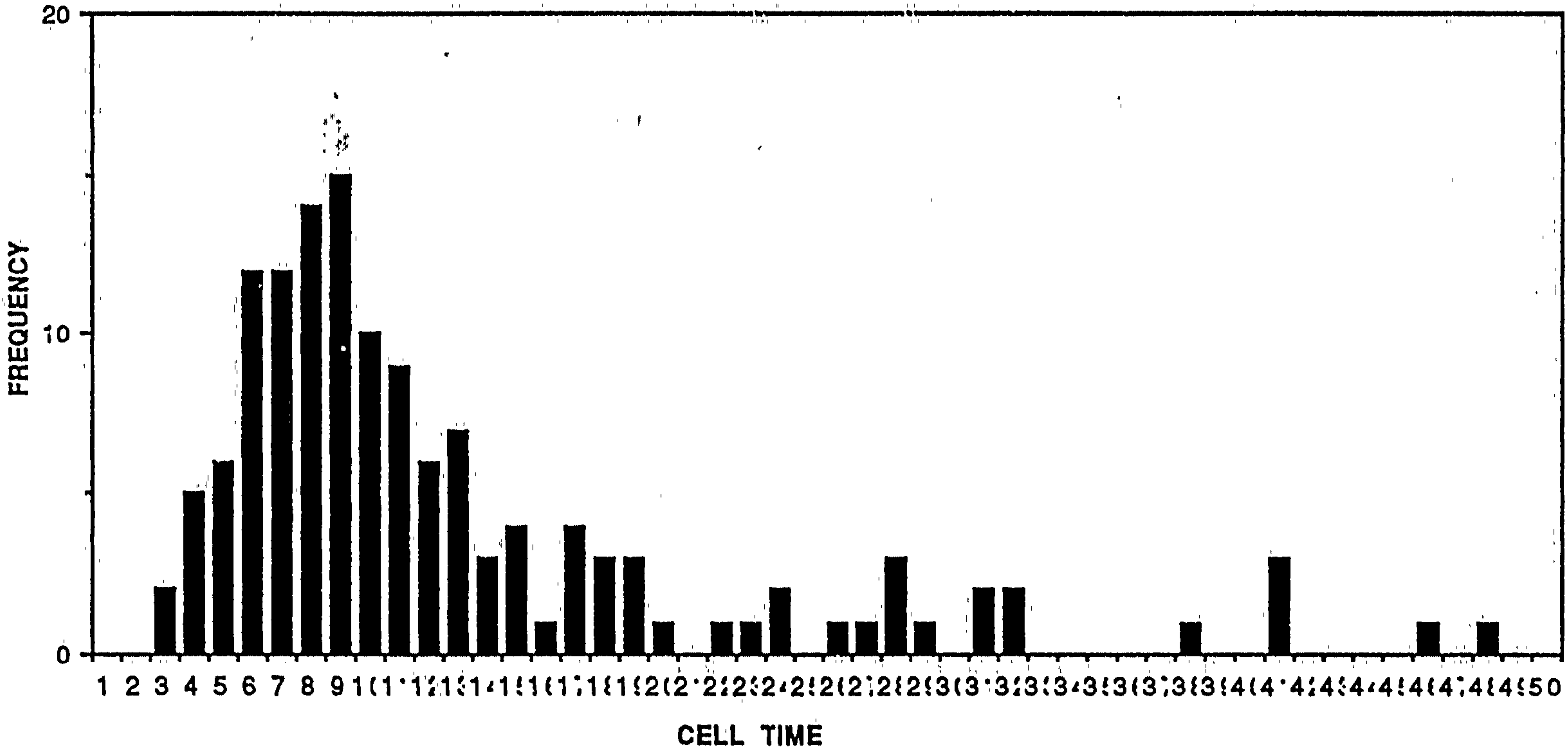


-397 CELL TIME (REJECTS)

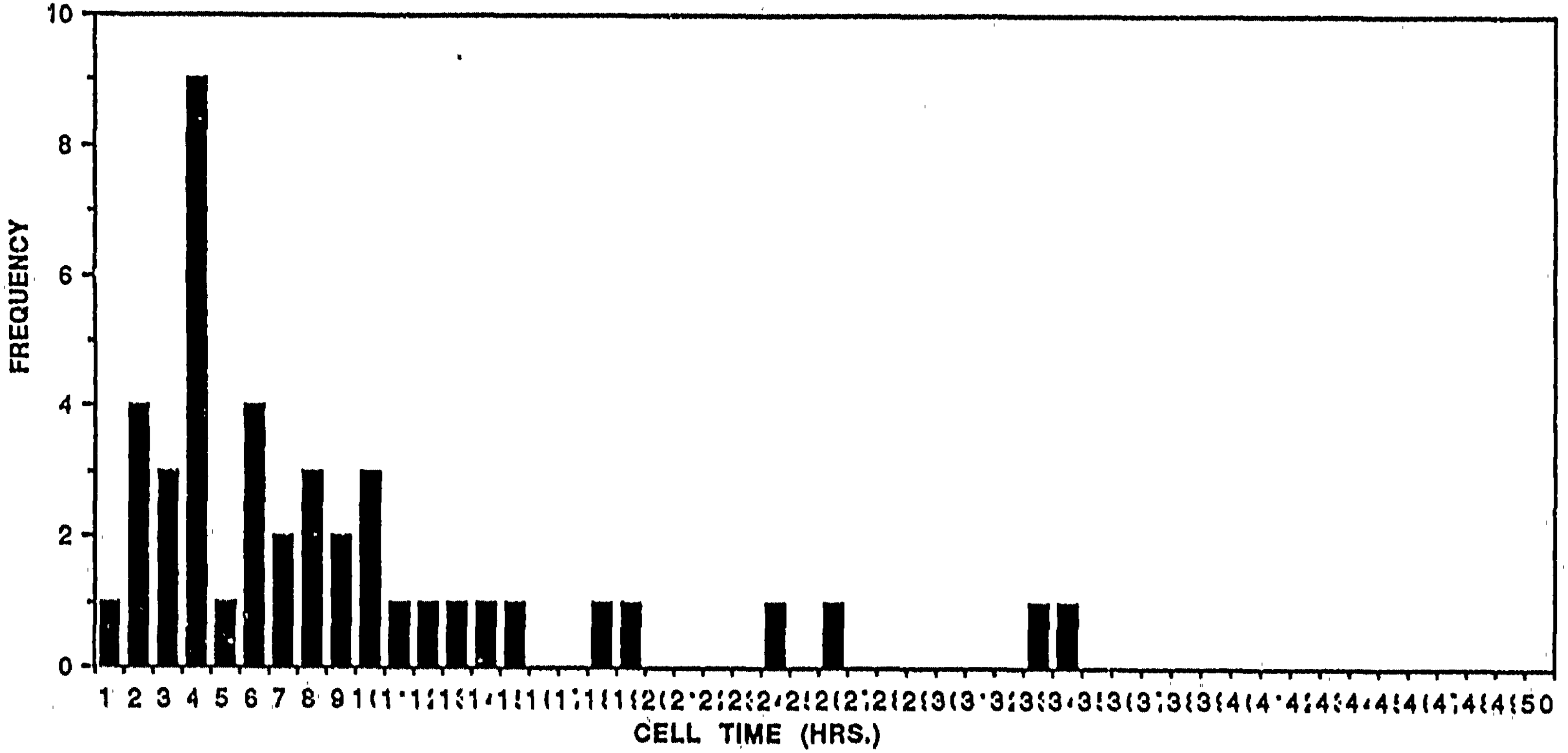
-180 CELL TIME (ACCEPTS VS REJECTS)



-180 CELL TIME (ACCEPTS)



-180 CELL TIME (REJECTS)



180 FINAL TECT DATA(S4) (by test cell #)

		TOTAL CELL TIME		COMPUTER RUN TIME			CORRECTED	
SERIAL NUM.	TEST CELL	HOURS	MINUTES	HOURS	MINUTES	STATUS	CELL TIME	COMP. TIME
P995	5	19	28	2	18	A	3.47	2.30
P528	5	19	33	2	31	A	3.55	2.52
P3379	5	22	13	2	25	A	6.22	2.42
P4326	5	22	51	2	9	A	6.85	2.15
P979	5	7	2	2	0	A	7.03	2.00
[illegible]44	5	24	11	2	10	A	8.18	2.17
[illegible]533	5	24	47	1	47	A	8.78	1.78
P37[illegible]9	5	24	52	2	11	R	8.87	2.18
P608	5	9	16	2	17	A	9.27	2.28
P008	5	26	11	1	48	A	10.18	1.80
P1982	5	44	47	2	5	R	12.78	2.08
P2907	5	28	52	2	42	A	12.87	2.70
P3426	5	29	40	2	32	A	13.67	2.53
P3907	5	30	12	2	23	A	14.20	2.38
P1593	5	48	10	1	54	A	16.17	1.90
P3905	5	49	56	2	8	A	17.93	2.13
P1539	5	74	47	2	16	A	26.78	2.27
P3395	5	62	11	2	18	A	30.18	2.30
P2365	5	119	37	3	35	A	39.62	3.58
P1539	5	12[illegible]	42	0	5	R	40.70	0.08
P3610	5	147	16	2	27	A	51.27	2.45
P4066	6	1	37	0	2	R	1.62	0.03
P1592	6	2	30	0	5	R	2.50	0.08
P926	6	2	47	0	37	R	2.78	0.62
P1631	6	20	21	2	16	A	4.35	2.27
P3233	5	20	49	2	13	A	4.82	2.22
P1420	6	20	51	1	49	A	4.85	1.82
P359	6	21	30	2	12	A	5.50	2.20
P556	6	5	52	0	56	R	5.87	0.93
P3951	6	21	59	1	48	A	5.98	1.80
P1287	6	6	18	2	2	A	6.30	2.03
P3471	6	22	39	0	49	R	6.65	0.82
P3274	6	23	7	1	59	A	7.12	1.98
P766	6	23	13	2	20	A	7.22	2.33
P[illegible]87	6	23	59	2	2	A	7.98	2.03
P1335	6	25	3	2	7	A	9.05	2.12
P2212	6	9	30	2	2	A	9.50	2.03
P1592	6	25	49	1	53	A	9.82	1.88
P3065	6	26	5	2	34	A	10.08	2.57
P2511	6	26	26	2	36	A	10.43	2.60
P884	6	26	30	0	59	R	10.50	0.98
P2491	6	27	10	2	25	A	11.32	2.42
P2511	6	27	23	2	56	A	11.38	2.93
P3083	6	27	30	2	36	A	11.50	2.60
P1856	6	27	41	2	25	A	11.68	2.42
P1500	6	27	51	2	17	A	11.85	2.28
P478	6	27	53	2	20	R	11.88	2.33
P124	6	28	2	1	55	A	12.03	1.92
P2894	6	28	52	2	21	A	12.87	2.35
P1880	6	47	38	1	56	A	15.63	1.93
P3104	6	47	42	1	57	A	15.70	1.95
P846	6	48	8	2	23	A	16.13	2.38
P978	6	48	50	2	45	A	16.83	2.75
P1880	6	49	9	1	46	R	17.15	1.77
P907	6	73	24	2	36	A	25.40	2.60
P884	6	59	55	1	51	A	27.92	1.85
P3593	6	96	10	2	7	R	32.17	2.12
P3719	7	3	26	0	6	A	3.43	0.10
P3583	7	5	5	0	0	A	5.08	0.00
P3419	7	21	22	2	3	A	5.37	2.05
P3301	7	21	36	1	51	A	5.60	1.85
P729	7	5	56	0	1	R	5.93	0.02
P1630	7	6	32	2	36	A	6.53	2.60
P3176	7	22	36	2	29	A	6.60	2.48
P347	7	23	18	0	53	R	7.30	0.88
P3108	7	23	48	2	48	A	7.80	2.80

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180 FINAL TEST DATA(S4)

P746	7	7	53	1	33	R	7.88	1.55
P545	7	8	13	3	42	A	8.22	3.70
P2909	7	8	23	2	10	A	8.38	2.17
P2301	7	24	46	1	39	R	8.77	1.65
P2318	7	25	34	2	34	A	9.57	2.57
P140	7	25	39	2	17	A	9.65	2.28
P2590	7	27	14	3	38	A	11.23	3.63
P1758	7	49	25	2	14	A	17.42	2.23
P001	7	49	42	2	28	A	17.70	2.47
P3288	7	49	53	2	21	A	17.88	2.35
P0611	7	125	13	5	44	A	45.22	5.73
P2212	8	2	37	1	6	R	2.62	1.10
P2350	8	20	12	2	58	A	4.20	2.97
P2511	8	5	10	1	2	R	5.17	1.03
P905	8	7	1	2	17	A	7.02	2.28
P334	8	7	37	2	26	A	7.62	2.43
P335	8	23	47	2	48	A	7.78	2.80
P001	8	23	55	0	39	R	7.92	0.65
P4066	8	24	49	3	8	A	8.82	3.13
P1877	8	25	11	3	17	A	9.18	3.28
P3896	8	9	22	2	33	A	9.37	2.55
P3789	8	25	52	3	38	A	9.87	3.63
P1510	8	11	32	2	48	A	11.53	2.80
P3398	8	33	24	2	16	A	17.40	2.27
P174	8	75	27	2	59	A	27.45	2.98
P1880	9	1	10	0	3	R	1.17	0.05
P001	9	1	11	0	1	R	1.18	0.02
P3036	9	17	32	2	2	A	1.53	2.03
P2502	9	17	37	2	21	A	1.62	2.35
P3426	9	3	8	0	12	R	3.13	0.20
P905	9	3	33	3	30	R	3.55	3.50
P164	9	3	51	1	57	A	3.85	1.95
P4071	9	4	48	2	12	A	4.80	2.20
P558	9	4	51	0	3	R	4.85	0.05
P3695	9	5	22	1	48	A	5.37	1.80
P281	9	21	46	2	24	A	5.77	2.40
P4090	9	5	52	2	6	A	5.87	2.10
P2544	9	5	55	2	8	A	5.92	2.13
P1036	9	6	6	2	4	A	6.10	2.07
P964	9	6	30	2	8	A	6.50	2.13
P3057	9	7	21	2	22	A	7.35	2.37
P3217	9	7	25	2	37	A	7.42	2.62
P2617	9	23	43	1	51	A	7.72	1.85
P2216	9	23	55	2	0	A	7.92	2.00
P3140	9	26	1	1	48	A	10.02	1.80
P2867	9	28	1	2	59	A	12.02	2.98
P3363	9	28	30	2	17	A	12.50	2.28
P3911	9	29	34	2	29	A	13.57	2.48
P0611	9	49	38	1	48	R	17.63	1.80
P1979	9	93	57	3	51	A	29.95	3.85
P3881	9	101	9	2	25	A	37.15	2.42
P472	9	143	10	2	37	A	47.17	2.62
P3646	10	0	13	0	2	R	0.22	0.03
P140	10	3	28	0	41	R	3.47	0.68
P1539	10	20	44	0	10	R	4.73	0.17
P3010	10	21	27	2	44	A	5.45	2.73
P1982	10	6	1	0	2	A	6.02	0.03
P3646	10	22	26	2	55	A	6.43	2.92
P1339	10	23	52	2	37	A	7.87	2.62
P1427	10	24	19	3	13	A	8.32	3.22
P347	10	24	59	2	37	A	8.98	2.62
P2121	10	25	16	3	48	A	9.27	3.80
P3655	10	25	27	2	45	A	9.45	2.75
P2212	10	25	33	1	12	R	9.55	1.20
P2458	10	27	1	2	42	A	11.02	2.70
P1015	10	47	19	2	25	A	15.32	2.42
P0190	10	69	22	2	47	A	21.37	2.78
P3363	10	39	13	1	12	R	23.22	1.20

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P4221	10	40	45	2	34	R	24.75	2.57
P3743	10	74	57	3	28	A	26.95	3.47
P140	10	97	28	0	41	R	33.47	0.68
P0322	10	120	25	3	51	A	40.42	3.85
P608	11	0	51	0	6	R	0.85	0.10
P4066	11	1	25	0	3	R	1.42	0.05
P478	11	1	46	0	1	R	1.77	0.02
P1631	11	2	15	0	51	R	2.25	0.85
P1880	11	2	40	0	1	R	2.67	0.02
P3774	11	2	46	1	39	A	2.77	1.65
P1397	11	2	56	2	4	A	2.93	2.07
P884	11	3	6	0	33	R	3.10	0.55
P2909	11	3	14	0	11	R	3.23	0.18
P3057	11	3	20	0	2	R	3.33	0.03
P1345	11	3	26	1	53	A	3.43	1.88
P2463	11	3	52	1	56	A	3.87	1.93
P3752	11	20	23	2	22	A	4.38	2.37
P0288	11	4	41	1	41	A	4.68	1.68
P1774	11	4	48	1	58	A	4.80	1.97
P0711	11	4	53	1	47	A	4.88	1.78
P3371	11	5	6	2	19	A	5.10	2.32
P3716	11	5	12	1	57	A	5.20	1.95
P3395	11	5	13	0	16	R	5.22	0.27
P2838	11	21	56	2	42	A	5.93	2.70
P2789	11	6	44	2	4	A	6.73	2.07
P3471	11	6	56	1	50	A	6.93	1.83
P4221	11	23	13	0	33	R	7.22	0.55
P3784	11	7	22	1	58	A	7.37	1.97
P1989	11	23	28	1	58	A	7.47	1.97
P897	11	23	48	1	53	A	7.80	1.88
P4074	11	8	11	1	52	A	8.18	1.87
P2298	11	24	25	3	9	A	8.42	3.15
P2909	11	24	36	0	32	R	8.60	0.53
P175	11	24	57	2	2	A	8.95	2.03
P558	11	26	56	2	3	A	10.93	2.05
P3255	11	27	14	2	20	A	11.23	2.33
P3792	11	30	3	2	2	A	14.05	2.03
P0190	11	14	13	0	4	R	14.22	0.07
P3851	11	35	5	1	48	A	19.08	1.80
P4316	11	70	23	2	8	A	22.38	2.13
P578	11	38	58	2	24	A	22.97	2.40
P578	11	39	5	4	48	A	23.08	4.80
P4221	11	74	2	2	37	A	26.03	2.62
P1889	11	94	43	3	7	A	30.72	3.12
P2177	11	94	43	1	54	A	30.72	1.90
P3934	11	119	34	2	20	A	39.57	2.33
P478	12	7	37	0	0	A	7.62	0.00
P2507	12	28	21	2	36	A	12.35	2.60
P978	5	546	7				CELL TIME	COMP. TIME
					TOTAL:	AVERAGE	11.41	1.99
						STAND. DEV.	9.72	1.00
					REJECTS:	AVERAGE	~~9.87~~	~~1.65~~
						STAND. DEV.	~~5.06~~	~~1.06~~
					ACCEPTS:	AVERAGE	~~11.90~~	~~2.10~~
						STAND. DEV.	~~9.91~~	~~0.96~~
				CELL #	COUNT	AVERAGE	STAND. DEV.	TOTAL TIME
				5	21	16.60	13.36	348.57
				6	36	10.95	6.78	394.37
				7	20	10.78	9.11	215.57
				8	14	9.71	6.19	135.93
				9	27	10.06	11.09	271.60
				10	20	13.81	10.88	276.25
				11	42	9.87	9.26	414.47

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		TOTAL CELL TIME		COMPUTER RUN TIME			CORRECTED	
SERIAL NUM.	TEST CELL	HOURS	MINUTES	HOURS	MINUTES	STATUS	CELL TIME	COMP. TIME
P30525	5	2	25	0	4	R	2.42	0.07
P30545	5	2	53	0	14	R	2.88	0.23
P30223	5	19	0	2	38	A	3.00	2.63
P30320	5	19	52	2	36	A	3.87	2.60
P30074	5	3	55	0	27	R	3.92	0.45
P30257	5	21	0	2	35	A	5.00	2.58
P30627	5	21	38	3	5	A	5.63	3.08
P31519	5	6	2	1	57	A	6.03	1.95
P30976	5	22	48	2	30	A	6.80	2.50
P31102	5	7	14	2	9	A	7.23	2.15
P31364	5	24	11	2	21	A	8.18	2.35
P30346	5	24	12	2	29	A	8.20	2.48
P30464	5	8	32	2	31	A	8.53	2.52
P31464	5	24	33	2	28	A	8.55	2.47
P31040	5	24	34	2	23	R	8.57	2.38
P30416	5	9	9	2	59	A	9.15	2.98
P30447	5	25	31	3	1	A	9.52	3.02
P19753	5	26	18	2	49	R	10.30	2.82
P30712	5	10	47	1	58	A	10.78	1.97
P19709	5	26	52	2	24	R	10.87	2.40
P31373	5	43	29	2	51	A	11.48	2.85
P30058	5	28	17	2	19	A	12.28	2.32
P31359	5	28	37	2	20	A	12.62	2.33
P30498	5	28	42	4	2	A	12.70	4.03
P30183	5	29	43	2	29	A	13.72	2.48
P30009	5	73	26	3	6	A	25.43	3.10
P19753	5	95	48	1	28	R	31.80	1.47
P30719	5	95	59	2	9	A	31.98	2.15
P19782	5	146	18	2	33	A	50.30	2.55
P30110	6	1	8	0	4	R	1.13	0.07
P30976	6	1	30	0	0	R	1.50	0.00
P31104	6	18	8	1	52	A	2.13	1.87
P30957	6	19	3	2	8	A	3.05	2.13
P30110	6	19	11	2	42	A	3.18	2.70
P19757	6	19	20	2	32	A	3.33	2.53
P24541	6	3	24	0	5	R	3.40	0.08
P30036	6	3	56	0	1	R	3.93	0.02
P30309	6	4	33	2	9	A	4.55	2.15
P30309	6	4	33	0	1	R	4.55	0.02
P30893	6	4	55	0	2	R	4.92	0.03
P19712	6	21	3	2	3	A	5.05	2.05
P30615	6	21	13	2	16	A	5.22	2.27
P30520	6	21	20	3	4	A	5.33	3.07
P31343	6	21	27	2	42	A	5.45	2.70
P31216	6	5	45	2	44	A	5.75	2.73
P31274	6	21	57	2	9	A	5.95	2.15
P30043	6	22	21	3	9	R	6.35	3.15
P31102	6	6	23	0	47	R	6.38	0.78
P19737	6	22	26	0	34	R	6.43	0.57
P31445	6	6	28	1	59	A	6.47	1.98
P30864	6	6	37	2	22	A	6.62	2.37
P30205	6	23	1	2	50	A	7.02	2.83
P30016	6	23	5	2	19	A	7.08	2.32
P30193	6	7	23	2	37	A	7.38	2.62
P30074	6	7	26	2	11	A	7.43	2.18
P30172	6	23	30	2	34	A	7.50	2.57
P31267	6	24	7	2	51	A	8.12	2.85
P31282	6	8	9	2	33	A	8.15	2.55
P31452	6	8	14	2	11	A	8.23	2.18
P30355	6	8	18	2	24	A	8.30	2.40
P19762	6	24	26	2	13	A	8.43	2.22
P30764	6	24	26	2	52	A	8.43	2.87
P30924	6	24	34	2	39	A	8.57	2.65
P30486	6	24	39	2	59	[illegible]	8.65	2.98
P31147	6	8	40	2	59	A	8.67	2.98
P19725	6	25	12	2	38	A	9.20	2.63

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P30905	6	9	12	3	3	A	9.20	3.05
P24511	6	25	36	2	31	A	9.60	2.52
P30525	6	9	55	2	50	A	9.92	2.83
P19737	6	26	15	2	15	A	10.25	2.25
P31065	6	26	26	2	25	A	10.43	2.42
P30959	6	26	30	4	0	A	10.50	4.00
P30029	6	27	3	2	59	A	11.05	2.98
P19761	6	29	5	2	28	A	13.08	2.47
P30591	6	46	9	3	54	A	14.15	3.90
P31102	6	47	13	0	39	R	15.22	0.65
P30691	6	47	42	2	55	A	15.70	2.92
P31129	6	48	0	3	20	A	16.00	3.33
P30297	6	16	13	0	28	R	16.22	0.47
P31496	6	51	2	2	25	A	19.03	2.42
P31460	6	54	20	2	28	A	22.33	2.47
P30491	6	38	51	3	39	A	22.85	3.65
P30205	6	71	25	2	23	A	23.42	2.38
P19713	6	72	56	2	28	A	24.93	2.47
P30403	6	75	31	4	15	A	27.52	4.25
P30588	6	97	13	3	54	A	33.22	3.90
P30503	6	118	41	2	59	A	38.68	2.98
31P5562	7	0	4	0	1	R	0.07	0.02
P30437	7	18	22	2	13	A	2.37	2.22
P31304	7	4	36	0	35	R	4.60	0.58
P30498	7	21	25	0	3	R	5.42	0.05
P30847	7	5	50	0	45	R	5.83	0.75
P30601	7	23	29	2	20	A	7.48	2.33
P30525	7	23	39	0	6	R	7.65	0.10
P31224	7	23	48	2	25	A	7.80	2.42
P30335	7	24	23	2	34	A	8.38	2.57
P31142	7	24	32	2	19	A	8.53	2.32
P30335	7	24	48	0	0	R	8.80	0.00
P30531	7	26	6	3	9	A	10.10	3.15
P30610	7	26	29	2	44	A	10.48	2.73
P31519	7	27	33	2	12	R	11.55	2.20
P30239	7	43	56	3	2	A	11.93	3.03
P30393	7	45	47	3	34	A	13.78	3.57
P30498	7	46	58	1	42	R	14.97	1.70
P30758	7	72	14	3	4	A	24.23	3.07
P30693	7	95	59	3	59	A	31.98	3.98
P30122	7	119	57	2	38	A	39.95	2.63
P30545	8	17	39	3	11	A	1.65	3.15
P19712	8	1	56	0	44	R	1.93	0.73
P30662	8	2	8	0	26	R	2.13	0.43
P30122	8	2	10	0	2	R	2.17	0.03
P24541	8	2	13	0	6	R	2.22	0.10
P30715	8	2	23	0	12	R	2.38	0.20
P31102	8	2	33	0	28	R	2.55	0.47
P19762	8	2	37	0	4	R	2.62	0.07
P30285	8	19	6	3	5	A	3.10	3.08
P31304	8	19	7	2	22	A	3.12	2.37
P30302	8	19	11	3	4	A	3.18	3.07
P31326	8	20	10	3	53	A	4.17	3.88
P19712	8	4	16	0	56	R	4.27	0.93
P30435	8	4	28	0	55	R	4.47	0.92
P19748	8	4	29	1	24	R	4.48	1.40
P30662	8	20	31	3	24	A	4.52	3.40
P30721	8	20	39	2	44	A	4.65	2.73
P30031	8	4	59	2	4	A	4.98	2.07
P30353	8	5	3	3	12	A	5.05	3.20
P30339	8	21	4	2	29	A	5.07	2.48
P31325	8	21	6	0	55	R	5.10	0.92
P31512	8	5	25	2	43	A	5.42	2.72
P30461	8	21	31	3	42	A	5.52	3.70
P30857	8	21	39	2	31	A	5.65	2.52
P30895	8	5	54	2	34	A	5.90	2.57
P24536	8	21	55	3	31	A	5.92	3.52
P30981	8	5	55	2	39	A	5.92	2.65

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P30715	8	6	5	2	25	A	6.08	2.42
P30318	8	22	10	2	36	A	6.17	2.60
P30403	8	6	11	1	9	R	6.18	1.15
P31302	8	6	15	2	26	A	6.25	2.43
P31215	8	22	23	2	55	A	6.38	2.92
P30333	8	6	30	2	46	A	6.50	2.77
P31047	8	6	31	2	32	A	6.52	2.53
P31291	8	6	38	2	40	A	6.63	2.67
P31325	8	6	38	3	23	A	6.63	3.38
P30598	8	23	0	3	0	A	7.00	3.00
P30567	8	23	4	2	53	A	7.07	2.88
P30755	8	23	12	2	25	A	7.20	2.42
P31459	8	23	26	2	20	A	7.43	2.33
P30422	8	7	46	2	44	A	7.77	2.73
P30715	8	23	56	3	26	R	7.93	3.43
P30913	8	24	2	3	11	A	8.03	3.18
P31118	8	24	22	3	7	A	8.37	3.12
P30090	8	24	27	2	14	A	8.45	2.23
P31380	8	24	32	2	45	A	8.53	2.75
P30733	8	24	47	2	58	A	8.78	2.97
P30949	8	25	38	3	10	A	9.63	3.17
P30480	8	25	59	2	32	A	9.98	2.53
P30957	8	26	6	1	46	R	10.10	1.77
P30847	8	26	44	2	22	A	10.73	2.37
P31461	8	10	58	3	39	A	10.97	3.65
P19978	8	27	24	3	24	A	11.40	3.40
P30816	8	29	15	3	39	A	13.25	3.65
P31478	8	47	25	2	43	A	15.42	2.72
P31277	8	15	49	2	34	A	15.82	2.57
P31330	8	16	31	2	23	A	16.52	2.38
P30290	8	52	54	3	43	A	20.90	3.72
P31102	8	71	8	0	38	R	23.13	0.63
P30378	8	72	33	3	29	A	24.55	3.48
P30308	8	72	54	2	48	A	24.90	2.80
P30756	9	1	5	0	1	R	1.08	0.02
P31343	9	2	9	0	12	R	2.15	0.20
P31229	9	18	59	2	45	A	2.98	2.75
P31192	9	3	10	0	0	A	3.17	0.00
P30331	9	3	15	0	7	R	3.25	0.12
P31146	9	3	15	2	20	R	3.25	2.33
P30464	9	3	22	0	5	R	3.37	0.08
P31040	9	19	59	3	37	A	3.98	3.62
P30993	9	20	27	2	19	A	4.45	2.32
P30802	9	4	44	2	5	A	4.73	2.08
P30290	9	5	10	0	2	R	5.17	0.03
P30396	9	5	16	2	8	A	5.27	2.13
P24505	9	21	24	2	58	A	5.40	2.97
P30547	9	5	25	2	10	A	5.42	2.17
P30525	9	5	28	0	2	R	5.47	0.03
P31431	9	5	28	2	19	A	5.47	2.32
P31016	9	21	40	3	29	A	5.67	3.48
P30196	9	5	45	2	3	A	5.75	2.05
P31455	9	5	47	2	36	A	5.78	2.60
P30345	9	21	53	1	52	A	5.88	1.87
P30719	9	21	58	0	37	R	5.97	0.62
P30232	9	6	4	2	0	A	6.07	2.00
P30893	9	22	13	2	31	A	6.22	2.52
P30570	9	6	16	2	23	A	6.27	2.38
P31510	9	6	17	2	30	A	6.28	2.50
P30669	9	6	23	2	19	A	6.38	2.32
P30304	9	6	24	2	15	A	6.40	2.25
P30505	9	6	28	2	26	A	6.47	2.43
P30505	9	6	28	2	26	A	6.47	2.43
P30829	9	6	28	2	44	A	6.47	2.73
P30218	9	22	36	2	34	A	6.60	2.57
P31218	9	22	37	2	55	A	6.62	2.92
P31003	9	6	46	1	48	A	6.77	1.80
P30811	9	6	49	2	13	A	6.82	2.22

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P30358	9	6	51	2	3	A	6.85	2.05
P30083	9	7	11	2	41	A	7.18	2.68
P31333	9	23	13	1	56	A	7.22	1.93
P31064	9	23	16	2	33	A	7.27	2.55
P31511	9	23	23	2	10	A	7.38	2.17
P30104	9	23	29	4	35	A	7.48	4.58
P30001	9	23	48	2	29	A	7.80	2.48
P30995	9	23	51	3	0	A	7.85	3.00
P30481	9	23	59	2	22	A	7.98	2.37
P30633	9	24	6	1	56	A	8.10	1.93
P30972	9	24	10	2	23	A	8.17	2.38
P31300	9	8	20	3	20	A	8.33	3.33
P19753	9	24	27	2	1	A	8.45	2.02
P30932	9	24	29	2	35	A	8.48	2.58
P31480	9	24	33	2	40	A	8.55	2.67
P30632	9	24	56	2	38	A	8.93	2.63
P30641	9	25	11	2	30	A	9.18	2.50
P24506	9	26	0	2	26	A	10.00	2.43
P31423	9	26	3	2	37	A	10.05	2.62
P31171	9	26	47	1	48	A	10.78	1.80
P30014	9	27	2	1	47	A	11.03	1.78
P30915	9	27	12	4	21	A	11.20	4.35
P30777	9	27	45	2	20	A	11.75	2.33
P24516	9	28	13	2	20	A	12.22	2.33
P30695	9	30	10	4	1	A	14.17	4.02
P30965	9	47	58	2	23	A	15.97	2.38
P30380	9	16	22	2	17	A	16.37	2.28
P30294	9	49	9	2	27	A	17.15	2.45
P30671	9	67	39	2	23	A	19.65	2.38
P31463	9	70	55	0	9	R	22.92	0.15
P19757	9	72	23	0	43	R	24.38	0.72
P30375	9	75	29	1	47	A	27.48	1.78
P30010	9	95	31	1	56	A	31.52	1.93
P31266	9	101	27	2	26	A	37.45	2.43
P24541	10	17	35	0	14	R	1.58	0.23
P31138	10	1	39	0	4	R	1.65	0.07
P30453	10	3	48	0	3	R	3.80	0.05
P19721	10	20	54	3	1	A	4.90	3.02
P3089	10	21	9	0	27	R	5.15	0.45
P31284	10	5	46	2	43	A	5.77	2.72
P30346	10	5	54	0	52	R	5.90	0.87
P30036	10	22	13	2	58	A	6.22	2.97
P19709	10	22	17	0	0	A	6.28	0.00
P30875	10	22	17	3	23	A	6.28	3.38
P30850	10	6	54	2	35	A	6.90	2.58
P30644	10	7	0	2	44	A	7.00	2.73
P30242	10	7	20	3	4	A	7.33	3.07
P30636	10	23	58	2	54	A	7.97	2.90
P31377	10	8	44	3	19	A	8.73	3.32
P30331	10	8	47	1	39	R	8.78	1.65
P31498	10	25	2	2	31	A	9.03	2.52
P30331	10	9	52	3	18	R	9.87	3.30
P31138	10	9	58	3	9	A	9.97	3.15
P30594	10	25	59	3	29	A	9.98	3.48
P31196	10	10	2	3	8	A	10.03	3.13
P30636	10	26	14	0	42	R	10.23	0.70
P30043	10	26	27	2	10	A	10.45	2.17
P30199	10	44	35	3	1	A	12.58	3.02
P30419	10	47	48	4	11	A	15.80	4.18
P30403	10	50	28	2	56	A	18.47	2.93
P30309	10	70	27	1	5	R	22.45	1.08
P30425	10	72	8	2	49	A	24.13	2.82
P30068	10	97	12	3	25	A	33.20	3.42
P30756	10	122	28	3	21	R	42.47	3.35
P30644	10	112	29	0	46	R	48.48	0.77
P30464	11	1	9	0	2	R	1.15	0.03
P19748	11	1	15	0	7	R	1.25	0.12
P24505	11	1	37	0	34	R	1.62	0.57

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P31007	11	1	52	0	9	R	1.87	0.15
P30671	11	2	2	0	17	R	2.03	0.28
P30924	11	2	47	0	24	R	2.78	0.40
P30671	11	2	54	0	23	R	2.90	0.38
P30498	11	2	56	0	12	R	2.93	0.20
P19766	11	19	2	2	57	A	3.03	2.95
P30670	11	3	33	2	32	A	3.55	2.53
P31187	11	3	36	1	59	A	3.60	1.98
P31398	11	3	36	1	43	A	3.60	1.72
P30897	11	19	44	2	36	A	3.73	2.60
P30227	11	19	48	1	51	A	3.80	1.85
P31139	11	3	53	2	9	A	3.88	2.15
P30604	11	19	55	2	14	A	3.92	2.23
P30994	11	4	17	2	0	A	4.28	2.00
P30069	11	4	20	2	23	A	4.33	2.38
P31400	11	4	25	1	48	A	4.42	1.80
P30242	11	4	39	1	40	R	4.65	1.67
P30507	11	20	55	2	13	A	4.92	2.22
P30493	11	5	2	2	2	A	5.03	2.03
P31325	11	5	9	0	5	R	5.15	0.08
P24504	11	5	26	2	29	A	5.43	2.48
P31202	11	5	33	2	50	A	5.55	2.83
P30296	11	5	46	2	29	A	5.77	2.48
P31007	11	5	50	2	21	A	5.83	2.35
P30420	11	6	27	2	35	A	6.45	2.58
P30846	11	6	34	2	34	A	6.57	2.57
P30036	11	22	42	3	9	R	6.70	3.15
P31088	11	7	32	2	27	A	7.53	2.45
P30924	11	24	6	0	11	R	8.10	0.18
P24509	11	24	21	2	11	A	8.35	2.18
P31216	11	24	21	1	56	R	8.35	1.93
P30167	11	26	34	2	43	A	10.57	2.72
P30756	11	10	38	2	41	A	10.63	2.68
P31019	11	26	50	0	28	R	10.83	0.47
P31482	11	28	12	2	21	A	12.20	2.35
P30661	11	66	46	1	40	A	18.77	1.67
P31224	11	69	39	1	9	R	21.65	1.15
P31102	11	70	18	0	38	R	22.30	0.63
P30783	11	75	25	1	58	A	27.42	1.97
P30196	11	91	29	2	39	A	27.48	2.65
P31114	11	91	47	0	41	R	27.78	0.68
P30982	11	94	14	3	56	A	30.23	3.93
P31463	11	114	29	4	0	A	34.48	4.00
P31146	11	117	47	5	39	A	37.78	5.65
P30390	12	10	28	2	6	A	10.47	2.10
							CELL TIME	COMP. TIME
					TOTAL:	AVERAGE	9.83	2.20
						STAND. DEV.	8.31	1.08
					REJECTS:	AVERAGE	~~10.60~~	~~2.03~~
						STAND. DEV.	~~10.18~~	~~1.22~~
					ACCEPTS:	AVERAGE	~~9.57~~	~~2.25~~
						STAND. DEV.	~~7.59~~	~~1.03~~
				CELL #	COUNT	AVERAGE	STAND. DEV.	TOTAL TIME
				5	29	11.78	10.50	341.75
				6	58	10.26	7.72	595.15
				7	20	11.80	9.76	235.92
				8	61	7.69	5.35	469.33
				9	68	9.07	6.71	616.77
				10	31	12.30	11.13	381.40
				11	47	9.47	9.58	445.20

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		TOTAL CELL TIME		COMPUTER RUN TIME			CORRECTED	
SERIAL NUM.	TEST CELL	HOURS	MINUTES	HOURS	MINUTES	STATUS	CELL TIME	COMP. TIME
P3036	9	17	32	2	2	A	1.53	2.03
P2502	9	17	37	2	21	A	1.62	2.35
P3774	11	2	46	1	39	A	2.77	1.65
P1397	11	2	56	2	4	A	2.93	2.07
P1345	11	3	26	1	53	A	3.43	1.88
P3719	7	3	26	0	6	A	3.43	0.10
P995	5	19	28	2	18	A	3.47	2.30
P528	5	19	33	2	31	A	3.55	2.52
P164	9	3	51	1	57	A	3.85	1.95
P2463	11	3	52	1	56	A	3.87	1.93
P2350	8	20	12	2	58	A	4.20	2.97
P1631	6	20	21	2	16	A	4.35	2.27
P3752	11	20	23	2	22	A	4.38	2.37
P0288	11	4	41	1	41	A	4.68	1.68
P1774	11	4	48	1	58	A	4.80	1.97
P4071	9	4	48	2	12	A	4.80	2.20
P3233	6	20	49	2	13	A	4.82	2.22
P1420	6	20	51	1	49	A	4.85	1.82
P0711	11	4	53	1	47	A	4.88	1.78
P3583	7	5	5	0	0	A	5.08	0.00
P3371	11	5	6	2	19	A	5.10	2.32
P3716	11	5	12	1	57	A	5.20	1.95
P3419	7	21	22	2	3	A	5.37	2.05
P3695	9	5	22	1	48	A	5.37	1.80
P3010	10	21	27	2	44	A	5.45	2.73
P359	6	21	30	2	12	A	5.50	2.20
P3301	7	21	36	1	51	A	5.60	1.85
P281	9	21	46	2	24	A	5.77	2.40
P4090	9	5	52	2	6	A	5.87	2.10
P2544	9	5	55	2	8	A	5.92	2.13
P2838	11	21	56	2	42	A	5.93	2.70
P3951	6	21	59	1	48	A	5.98	1.80
P1982	10	6	1	0	2	A	6.02	0.03
P1036	9	6	6	2	4	A	6.10	2.07
P3379	5	22	13	2	25	A	6.22	2.42
P1287	6	6	18	2	2	A	6.30	2.03
P3646	10	22	26	2	55	A	6.43	2.92
P964	9	6	30	2	8	A	6.50	2.13
P1630	7	6	32	2	36	A	6.53	2.60
P3176	7	22	36	2	29	A	6.60	2.48
P2789	11	6	44	2	4	A	6.73	2.07
P4326	5	22	51	2	9	A	6.85	2.15
P3471	11	6	56	1	50	A	6.93	1.83
P905	8	7	1	2	17	A	7.02	2.28
P979	5	7	2	2	0	A	7.03	2.00
P3274	6	23	7	1	59	A	7.12	1.98
P766	6	23	13	2	20	A	7.22	2.33
P3057	9	7	21	2	22	A	7.35	2.37
P3784	11	7	22	1	58	A	7.37	1.97
P3217	9	7	25	2	37	A	7.42	2.62
P1989	11	23	28	1	58	A	7.47	1.97
P334	8	7	37	2	26	A	7.62	2.43
P478	12	7	37	0	0	A	7.62	0.00
P2617	9	23	43	1	51	A	7.72	1.85
P335	8	23	47	2	48	A	7.78	2.80
P3108	7	23	48	2	48	A	7.80	2.80
P897	11	23	48	1	53	A	7.80	1.88
P1339	10	23	52	2	37	A	7.87	2.62
P2216	9	23	55	2	0	A	7.92	2.00
P487	6	23	59	2	2	A	7.98	2.03
P4074	11	8	11	1	52	A	8.18	1.87
P844	5	24	11	2	10	A	8.18	2.17
P545	7	8	13	3	42	A	8.22	3.70
P1427	10	24	19	3	13	A	8.32	3.22
P2909	7	8	23	2	10	A	8.38	2.17
P2298	11	24	25	3	9	A	8.42	3.15

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P3533	5	24	47	1	47	A	8.78	1.78
P4066	8	24	49	3	8	A	8.82	3.13
P175	11	24	57	2	2	A	8.95	2.03
P347	10	24	59	2	37	A	8.98	2.62
P1335	6	25	3	2	7	A	9.05	2.12
P1877	8	25	11	3	17	A	9.18	3.28
P2121	10	25	16	3	48	A	9.27	3.80
P608	5	9	16	2	17	A	9.27	2.28
P3896	8	9	22	2	33	A	9.37	2.55
P3655	10	25	27	2	45	A	9.45	2.75
P2212	6	9	30	2	2	A	9.50	2.03
P2318	7	25	34	2	34	A	9.57	2.57
P140	7	25	39	2	17	A	9.65	2.28
P1592	6	25	49	1	53	A	9.82	1.88
P3789	8	25	52	3	38	A	9.87	3.63
P3140	9	26	1	1	48	A	10.02	1.80
P3065	6	26	5	2	34	A	10.08	2.57
P008	5	26	11	1	48	A	10.18	1.80
P2511	6	26	26	2	36	A	10.43	2.60
P558	11	26	56	2	3	A	10.93	2.05
P2458	10	27	1	2	42	A	11.02	2.70
P2590	7	27	14	3	38	A	11.23	3.63
P3255	11	27	14	2	20	A	11.23	2.33
P2491	6	27	19	2	25	A	11.32	2.42
P2511	6	27	23	2	56	A	11.38	2.93
P3383	6	27	30	2	36	A	11.50	2.60
P1510	8	11	32	2	48	A	11.53	2.80
P1856	6	27	41	2	25	A	11.68	2.42
P1500	6	27	51	2	17	A	11.85	2.28
P2867	9	28	1	2	59	A	12.02	2.98
P124	6	28	2	1	55	A	12.03	1.92
P2507	12	28	21	2	36	A	12.35	2.60
P3363	9	28	30	2	17	A	12.50	2.28
P2894	6	28	52	2	21	A	12.87	2.35
P2907	5	28	52	2	42	A	12.87	2.70
P3911	9	29	34	2	29	A	13.57	2.48
P3426	5	29	40	2	32	A	13.67	2.53
P3792	11	30	3	2	2	A	14.05	2.03
P3907	5	30	12	2	23	A	14.20	2.38
P1015	10	47	19	2	25	A	15.32	2.42
P1880	6	47	38	1	56	A	15.63	1.93
P3104	6	47	42	1	57	A	15.70	1.95
P846	6	48	8	2	23	A	16.13	2.38
P1593	5	48	10	1	54	A	16.17	1.90
P978	6	48	50	2	45	A	16.83	2.75
P3398	8	33	24	2	16	A	17.40	2.27
P1758	7	49	25	2	14	A	17.42	2.23
P001	7	49	42	2	28	A	17.70	2.47
P3288	7	49	53	2	21	A	17.88	2.35
P3905	5	49	56	2	8	A	17.93	2.13
P3851	11	35	5	1	48	A	19.08	1.80
P0190	10	69	22	2	47	A	21.37	2.78
P4316	11	70	23	2	8	A	22.38	2.13
P578	11	38	58	2	24	A	22.97	2.40
P578	11	39	5	4	48	A	23.08	4.80
P907	6	73	24	2	36	A	25.40	2.60
P4221	11	74	2	2	37	A	26.03	2.62
P1539	5	74	47	2	16	A	26.78	2.27
P374[illegible]	10	74	57	3	28	A	26.95	3.47
P174	8	75	27	2	59	A	27.45	2.98
P884	6	59	55	1	51	A	27.92	1.85
P1979	9	93	57	3	51	A	29.95	3.85
P3395	5	62	11	2	18	A	30.18	2.30
P1889	11	94	43	3	7	A	30.72	3.12
P2177	11	94	43	1	54	A	30.72	1.90
P3881	9	101	9	2	25	A	37.15	2.42
P3934	11	119	34	2	20	A	39.57	2.33
P2365	5	119	37	3	35	A	39.62	3.58

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180 FINAL TEST DATA(S3)

P0322	10	120	25	3	51	A	40.42	3.85
P0611	7	125	13	5	44	A	45.22	5.73
P472	9	143	10	2	37	A	47.17	2.62
P3610	5	147	16	2	27	A	51 27	2.45
P3646	10	0	13	0	2	R	0.22	0.03
P608	11	0	51	0	6	R	0.85	0.10
P1880	9	1	10	0	3	R	1.17	0.05
P001	9	1	11	0	1	R	1.18	0.02
P4066	11	1	25	0	3	R	1.42	0.05
P4066	6	1	37	0	2	R	1.62	0.03
P478	11	1	46	0	1	R	1.77	0.02
P1631	11	2	15	0	51	R	2.25	0.85
P1592	6	2	30	0	5	R	2.50	0.08
P2212	8	2	37	1	6	R	2.62	1.10
P1880	11	2	40	0	1	R	2.67	0.02
P926	6	2	47	0	37	R	2.78	0.62
P884	11	3	6	0	33	R	3.10	0.55
P3426	9	3	8	0	12	R	3.13	0.20
P2909	11	3	14	0	11	R	3.23	0.18
P3057	11	3	20	0	2	R	3.33	0.03
P140	10	3	28	0	41	R	3.47	0.68
P905	9	3	33	3	30	R	3.55	3.50
P1539	10	20	44	0	10	R	4.73	0.17
P558	9	4	51	0	3	R	4.85	0.05
P2511	8	5	10	1	2	R	5.17	1.03
P3395	11	5	13	0	16	R	5.22	0.27
P558	6	5	52	0	56	R	5.87	0.93
P729	7	5	56	0	1	R	5.93	0.02
P3471	6	22	39	0	49	R	6.65	0.82
P4221	11	23	13	0	33	R	7.22	0.55
P347	7	23	18	0	53	R	7.30	0.88
P746	7	7	53	1	33	R	7.88	1.55
P001	8	23	55	0	39	R	7.92	0.65
P2909	11	24	36	0	32	R	8.60	0.53
P2301	7	24	46	1	39	R	8.77	1.65
P3719	5	24	52	2	11	R	8.87	2.18
P2212	10	25	33	1	12	R	9.55	1.20
P884	6	26	30	0	59	R	10.50	0.98
P478	6	27	53	2	20	R	11.88	2.33
P1982	5	44	47	2	5	R	12.78	2.08
P0190	11	14	13	0	4	R	14.22	0.07
P1880	6	49	9	1	46	R	17.15	1 77
P0611	9	49	38	1	48	R	17.63	1.80
P3363	10	39	13	1	12	R	23.22	1.20
P4221	10	40	45	2	34	R	24.75	2.57
P3583	6	96	10	2	7	R	32.17	2.12
P140	10	97	28	0	41	R	33.47	0.68
P1539	5	120	42	0	5	R	40.70	0.08
P978	5	546	7				CELL TIME	COMP. TIME
					TOTAL:	AVERAGE	11.41	1.99
						STAND. DEV.	9.72	1.00
					REJECTS:	AVERAGE	8.72	0.82
						STAND. DEV.	9.29	0.86
					ACCEPTS:	AVERAGE	12.27	2.36
						STAND DEV	9 74	0 72

397 FINAL TEST DATA(S2)

		TOTAL CELL TIME		COMPUTER RUN TIME			CORRECTED	
SERIAL NUM.	TEST CELL	HOURS	MINUTES	HOURS	MINUTES	STATUS	CELL TIME	COMP. TIME
P30545	8	17	39	3	11	A	1.65	3.18
P31104	6	18	8	1	52	A	2.13	1.87
P30437	7	18	22	2	13	A	2.37	2.22
P31229	9	18	59	2	45	A	2.98	2.75
P30223	5	19	0	2	38	A	3.00	2.63
P19766	11	19	2	2	57	A	3.03	2.95
P30957	6	19	3	2	8	A	3.05	2.13
P30285	8	19	6	3	5	A	3.10	3.08
P31304	8	19	7	2	22	A	3.12	2.37
P31192	9	3	10	0	0	A	3.17	0.00
P30110	6	19	11	2	42	A	3.18	2.70
P30302	8	19	11	3	4	A	3.18	3.07
P19757	6	19	20	2	32	A	3.33	2.53
P30670	11	3	33	2	32	A	3.55	2.53
P31187	11	3	36	1	59	A	3.60	1.98
P31398	11	3	36	1	43	A	3.60	1.72
P30897	11	19	44	2	36	A	3.73	2.60
P30227	11	19	48	1	51	A	3.80	1.85
P30320	5	19	52	2	36	A	3.87	2.60
P31139	11	3	53	2	9	A	3.88	2.15
P30604	11	19	55	2	14	A	3.92	2.23
P31040	9	19	59	3	37	A	3.98	3.62
P31326	8	20	10	3	53	A	4.17	3.88
P30994	11	4	17	2	0	A	4.28	2.00
P30069	11	4	20	2	23	A	4.33	2.38
P31400	11	4	25	1	48	A	4.42	1.80
P30993	9	20	27	2	19	A	4.45	2.32
P30662	8	20	31	3	24	A	4.52	3.40
P30309	6	4	33	2	9	A	4.55	2.15
P30721	8	20	39	2	44	A	4.65	2.73
P30802	9	4	44	2	5	A	4.73	2.08
P19721	10	20	54	3	1	A	4.90	3.02
P30507	11	20	55	2	13	A	4.92	2.22
P30031	8	4	59	2	4	A	4.98	2.07
P30257	5	21	0	2	35	A	5.00	2.58
P30493	11	5	2	2	2	A	5.03	2.03
P19712	6	21	3	2	3	A	5.05	2.05
P30353	8	5	3	3	12	A	5.05	3.20
P30339	8	21	4	2	29	A	5.07	2.48
P30615	6	21	13	2	16	A	5.22	2.27
P30396	9	5	16	2	8	A	5.27	2.13
P30520	6	21	20	3	4	A	5.33	3.07
P24505	9	21	24	2	58	A	5.40	2.97
P30547	9	5	25	2	10	A	5.42	2.17
P31512	8	5	25	2	43	A	5.42	2.72
P24504	11	5	26	2	29	A	5.43	2.48
P31343	6	21	27	2	42	A	5.45	2.70
P31431	9	5	28	2	19	A	5.47	2.32
P30461	8	21	31	3	42	A	5.52	3.70
P31202	11	5	33	2	50	A	5.55	2.83
P30627	5	21	38	3	5	A	5.63	3.08
P30857	8	21	39	2	31	A	5.65	2.52
P31016	9	21	40	3	29	A	5.67	3.48
P30196	9	5	45	2	3	A	5.75	2.05
P31216	6	5	45	2	44	A	5.75	2.73
P30296	11	5	46	2	29	A	5.77	2.48
P31284	10	5	46	2	43	A	5.77	2.72
P31455	9	5	47	2	36	A	5.78	2.60
P31007	11	5	50	2	21	A	5.83	2.35
P30345	9	21	53	1	52	A	5.89	1.87
P30895	8	5	54	2	34	A	5.90	2.57
P24536	8	21	55	3	31	A	5.92	3.52
P30981	8	5	55	2	39	A	5.92	2.65
P31274	6	21	57	2	9	A	5.95	2.15
P31519	5	6	2	1	57	A	6.03	1.95
P30232	9	6	4	2	0	A	6.07	2.00

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P30715	8	6	5	2	25	A	6.08	2.42
P30318	8	22	10	2	36	A	6.17	2.60
P30036	10	22	13	2	58	A	6.22	2.97
P30893	9	22	13	2	31	A	6.22	2.52
P31302	8	6	15	2	26	A	6.25	2.43
P30570	9	6	16	2	23	A	6.27	2.38
P19709	10	22	17	0	0	A	6.28	0.00
P30875	10	22	17	3	23	A	6.28	3.38
P31510	9	6	17	2	30	A	6.28	2.50
P30669	9	6	23	2	19	A	6.38	2.32
P31215	8	22	23	2	55	A	6.38	2.92
P30304	9	6	24	2	15	A	6.40	2.25
P30420	11	6	27	2	35	A	6.45	2.58
P30505	9	6	28	2	26	A	6.47	2.43
P30505	9	6	28	2	26	A	6.47	2.43
P30829	9	6	28	2	44	A	6.47	2.73
P31445	6	6	28		59	A	6.47	1.98
P30333	8	6	30	2	46	A	6.50	2.77
P31047	8	6	31	2	32	A	6.52	2.53
P30846	11	6	34	2	34	A	6.57	2.57
P30218	9	22	36	2	34	A	6.60	2.57
P30864	6	6	37	2	22	A	6.62	2.37
P31218	9	22	37	2	55	A	6.62	2.92
P31291	8	6	38	2	40	A	6.63	2.67
P31325	8	6	38	3	23	A	6.63	3.38
P31003	9	6	46	1	48	A	6.77	1.80
P30976	5	22	48	2	30	A	6.80	2.50
P30811	9	6	49	2	13	A	6.82	2.22
P30358	9	6	51	2	3	A	6.85	2.05
P30850	10	6	54	2	35	A	6.90	2.58
P30598	8	23	0	3	0	A	7.00	3.00
P30644	10	7	0	2	44	A	7.00	2.73
P30205	6	23	1	2	50	A	7.02	2.83
P30567	8	23	4	2	53	A	7.07	2.88
P30016	6	23	5	2	19	A	7.08	2.32
P30083	9	7	11	2	41	A	7.18	2.68
P30755	8	23	12	2	25	A	7.20	2.42
P31333	9	23	13	1	56	A	7.22	1.93
P31102	5	7	14	2	9	A	7.23	2.15
P31064	9	23	16	2	33	A	7.27	2.55
P30242	10	7	20	3	4	A	7.33	3.07
P30193	6	7	23	2	37	A	7.38	2.62
P31511	9	23	23	2	10	A	7.38	2.17
P30074	6	7	26	2	11	A	7.43	2.18
P31459	8	23	26	2	20	A	7.43	2.33
P30104	9	23	29	4	35	A	7.48	4.58
P30601	7	23	29	2	20	A	7.48	2.33
P30172	6	23	30	2	34	A	7.50	2.57
P31088	11	7	32	2	27	A	7.53	2.45
P30422	8	7	46	2	44	A	7.77	2.73
P30001	9	23	48	2	29	A	7.80	2.48
P31224	7	23	48	2	25	A	7.80	2.42
P30995	9	23	51	3	0	A	7.85	3.00
P30636	10	23	58	2	54	A	7.97	2.90
P30481	9	23	59	2	22	A	7.98	2.37
P30913	8	24	2	3	11	A	8.03	3.18
P30633	9	24	6	1	56	A	8.10	1.93
P31267	6	24	7	2	51	A	8.12	2.85
P31282	6	8	9	2	33	A	8.15	2.55
P30972	9	24	10	2	23	A	8.17	2.38
P31364	5	24	11	2	21	A	8.18	2.35
P30346	5	24	12	2	29	A	8.20	2.48
P31452	6	8	14	2	11	A	8.23	2.18
P30355	6	8	18	2	24	A	8.30	2.40
P31300	9	8	20	3	20	A	8.33	3.33
P24509	11	24	21	2	11	A	8.35	2.18
P31118	8	24	22	3	7	A	8.37	3.12
P30335	7	24	23	2	34	A	8.38	2.57

P19762	6	24	26	2	13	A	8.43	2.22
P30764	6	24	26	2	52	A	8.43	2.87
P19753	9	24	27	2	1	A	8.45	2.02
P30090	8	24	27	2	14	A	8.45	2.23
P30932	9	24	29	2	35	A	8.48	2.58
P30464	5	8	32	2	31	A	8.53	2.52
P31142	7	24	32	2	19	A	8.53	2.32
P31380	8	24	32	2	45	A	8.53	2.75
P31464	5	24	33	2	28	A	8.55	2.47
P31480	9	24	33	2	40	A	8.55	2.67
P30924	6	24	34	2	39	A	8.57	2.65
P30486	6	24	39	2	59	A	8.65	2.98
P31147	6	8	40	2	59	A	8.67	2.98
P31377	10	8	44	3	19	A	8.73	3.32
P30733	8	24	47	2	58	A	8.78	2.97
P30632	9	24	56	2	38	A	8.93	2.63
P31498	10	25	2	2	31	A	9.03	2.52
P30416	5	9	9	2	59	A	9.15	2.98
P30641	9	25	11	2	30	A	9.18	2.50
P19725	6	25	12	2	38	A	9.20	2.63
P30905	6	9	12	3	3	A	9.20	3.05
P30447	5	25	31	3	1	A	9.52	3.02
P24511	6	25	36	2	31	A	9.60	2.52
P30949	8	25	38	3	10	A	9.63	3.17
P30525	6	9	55	2	50	A	9.92	2.83
P31138	10	9	58	3	9	A	9.97	3.15
P30480	8	25	59	2	32	A	9.98	2.53
P30594	10	25	59	3	29	A	9.98	3.48
P24506	9	26	0	2	26	A	10.00	2.43
P31196	10	10	2	3	8	A	10.03	3.13
P31423	9	26	3	2	37	A	10.05	2.62
P30531	7	26	6	3	9	A	10.10	3.15
P19737	6	26	15	2	15	A	10.25	2.25
P31065	6	26	26	2	25	A	10.43	2.42
P30043	10	26	27	2	10	A	10.45	2.17
P30390	12	10	28	2	6	A	10.47	2.10
P30610	7	26	29	2	44	A	10.48	2.73
P30959	6	26	30	4	0	A	10.50	4.00
P30167	11	26	34	2	43	A	10.57	2.72
P30756	11	10	38	2	41	A	10.63	2.68
P30847	8	26	44	2	22	A	10.73	2.37
P30712	5	10	47	1	58	A	10.78	1.97
P31171	9	26	47	1	48	A	10.78	1.80
P31461	8	10	58	3	39	A	10.97	3.65
P30014	9	27	2	1	47	A	11.03	1.78
P30029	6	27	3	2	59	A	11.05	2.98
P30915	9	27	12	4	21	A	11.20	4.35
P19978	8	27	24	3	24	A	11.40	3.40
P31373	5	43	29	2	51	A	11.48	2.85
P30777	9	27	45	2	20	A	11.75	2.33
P30239	7	43	56	3	2	A	11.93	3.03
P31482	11	28	12	2	21	A	12.20	2.35
P24516	9	28	13	2	20	A	12.22	2.33
P30058	5	28	17	2	19	A	12.28	2.32
P30199	10	44	35	3	1	A	12.58	3.02
P31359	5	28	37	2	20	A	12.62	2.33
P30498	5	28	42	4	2	A	12.70	4.03
P19761	6	29	5	2	28	A	13.08	2.47
P30816	8	29	15	3	39	A	13.25	3.65
P30183	5	29	43	2	29	A	13.72	2.48
P30393	7	45	47	3	34	A	13.78	3.57
P30591	6	46	9	3	54	A	14.15	3.90
P30695	3	30	10	4	1	A	14.17	4.02
P31478	8	47	25	2	43	A	15.42	2.72
P30691	6	47	42	2	55	A	15.70	2.92
P30419	10	47	48	4	11	A	15.80	4.18
P31277	8	15	49	2	34	A	15.82	2.57
P30965	9	47	58	2	23	A	15.97	2.38

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P31129	6	48	0	3	20	A	16.00	3.33
P30380	9	16	22	2	17	A	16.37	2.28
P31330	8	18	31	2	23	A	16.52	2.38
P30294	9	49	9	2	27	A	17.15	2.4
P30403	10	50	28	2	56	A	18 47	2.9
P30661	11	66	46	1	40	A	18.77	1.67
P31496	6	51	2	2	25	A	19.03	2.42
P30671	9	67	39	2	23	A	19.65	2.38
P30290	8	52	54	3	43	A	20.90	3 72
P31460	6	54	20	2	28	A	22.33	2.47
P30491	6	58	51	3	39	A	22.85	3.65
P30205	6	71	25	2	23	A	23.42	2.38
P30425	10	72	8	2	49	A	24.13	2.82
P30758	7	72	14	3	4	A	24.23	3.07
P30378	8	72	33	3	29	A	24.55	3.48
P30308	8	72	54	2	48	A	24.90	2.80
P19713	6	72	56	2	28	A	24 93	2.47
P30009	5	73	26	3	6	A	25.43	3.10
P30783	11	75	25	1	58	A	27.42	1 97
P30196	11	91	29	2	39	A	27 48	2.65
P30375	9	75	29	1	47	A	27.48	1.78
P30403	6	75	31	4	15	A	27.52	4.25
P30982	11	94	14	3	56	A	30.23	3.93
P30010	9	95	31	1	56	A	31.52	1.93
P30693	7	95	59	3	59	A	31.98	3.98
P30719	5	95	59	2	9	A	31.98	2.15
P30068	10	97	12	3	25	A	33.20	3.42
P30588	6	97	13	3	54	A	33.22	3.90
P31463	11	114	29	4	0	A	34.48	4.00
P31266	9	101	27	2	26	A	37.45	2.43
P31146	11	117	47	5	39	A	37.78	5.65
P30503	6	118	41	2	59	A	38.68	2.98
P30122	7	119	57	2	38	A	39.95	2.63
P19782	5	146	18	2	33	A	50.30	2.55
31P5562	7	0	4	0	1	R	0.07	0.02
P30756	9	1	5	0	1	R	1.08	0.02
P30110	6	1	8	0	4	R	1.13	0.07
P30464	11	1	9	0	2	R	1.15	0.03
P19748	11	1	15	0	7	R	1.25	0.12
P30976	6	1	30	0	0	R	1.50	0.00
P24541	10	17	35	0	14	R	1.58	0.23
P24505	11	1	37	0	34	R	1.62	0.57
P31138	10	1	39	0	4	R	1 65	0 07
P31007	11	1	52	0	9	R	1 87	0.15
P19712	8	1	56	0	44	R	1.93	0.73
P30671	11	2	2	0	17	R	2.03	0.28
P30662	9	2	8	0	26	R	2.13	0.43
P31343	9	2	9	0	12	R	2 15	0 20
P30122	8	2	10	0	2	R	2.17	0.03
P24541	8	2	13	0	6	R	2 22	0.10
P30715	8	2	23	0	12	R	2.38	0.20
P30525	5	2	25	0	4	R	2.42	0 07
P31102	8	2	33	0	28	R	2.55	0.47
P19762	8	2	37	0	4	R	2.62	0.07
P30924	11	2	47	0	24	R	2.78	0.40
P30545	5	2	53	0	14	R	2.88	0.23
P30671	11	2	54	0	23	R	2.90	0.38
P30498	11	2	56	0	12	R	2.93	0.20
P30331	9	3	15	0	7	R	3.25	0 12
P31146	9	3	15	2	20	R	3 25	2 33
P30464	9	3	22	0	5	R	3.37	0.08
P24541	6	3	24	0	5	R	3.40	0 08
P30453	10	3	48	0	3	R	3.80	0.05
P30074	5	3	55	0	27	R	3 92	0 45
P30036	6	3	56	0	1	R	3 93	0.02
P19712	5	4	16	0	56	R	4.27	0.93
P30435	8	4	28	0	55	R	4.47	0.92
P19748	8	4	29	1	24	R	4 48	1.40

397 FINAL TEST DATA(S2)

P30309	6	4	33	0	1	R	4.55	0.02
P31304	7	4	36	0	35	R	4.60	0.58
P30242	11	4	39	1	40	R	4.65	1.67
P30893	6	4	55	0	2	R	4.92	0.03
P31325	8	21	6	0	55	R	5.10	0.92
P3089	10	21	9	0	27	R	5.15	0.45
P31325	11	5	9	0	5	R	5.15	0.08
P30290	9	5	10	0	2	R	5.17	0.03
P30498	7	21	25	0	3	R	5.42	0.05
P30525	9	5	28	0	2	R	5.47	0.03
P30847	7	5	50	0	45	R	5.83	0.75
P30346	10	5	54	0	52	R	5.90	0.87
P30719	9	21	58	0	37	R	5.97	0.62
P30403	8	6	11	1	9	R	6.18	1.15
P30043	6	22	21	3	9	R	6.35	3.15
P31102	6	6	23	0	47	R	6.38	0.78
P19737	6	22	26	0	34	R	6.43	0.57
P30036	11	22	42	3	9	R	6.70	3.15
P30525	7	23	39	0	6	R	7.65	0.10
P30715	8	23	56	3	26	R	7.93	3.43
P30924	11	24	6	0	11	R	8.10	0.18
P31216	11	24	21	1	56	R	8.35	1.93
P31040	5	24	34	2	23	R	8.57	2.38
P30331	10	8	47	1	39	R	8.78	1.65
P30335	7	24	48	0	0	R	8.80	0.00
P30331	10	9	52	3	18	R	9.87	3.30
P30957	8	26	6	1	46	R	10.10	1.77
P30636	10	26	14	0	42	R	10.23	0.70
P19753	5	26	18	2	49	R	10.30	2.82
P31019	11	26	50	0	28	R	10.83	0.47
P19709	5	26	52	2	24	R	10.87	2.40
P31519	7	27	33	2	12	R	11.55	2.20
P30498	7	46	58	1	42	R	14.97	1.70
P31102	6	47	13	0	39	R	15.22	0.65
P30297	6	16	13	0	28	R	16.22	0.47
P31224	11	69	39	1	9	R	21.65	1.15
P31102	11	70	18	0	38	R	22.30	0.63
P30309	10	70	27	1	5	R	22.45	1.08
P31463	9	70	55	0	9	R	22.92	0.15
P31102	8	71	8	0	38	R	23.13	0.63
P19757	9	72	23	0	43	R	24.38	0.72
P31114	11	91	47	0	41	R	27.78	0.68
P19753	5	95	48	1	28	R	31.80	1.47
P30756	10	122	28	3	21	R	42.47	3.35
P30644	10	112	29	0	46	R	48.48	0.77
							CELL TIME	**COMP. TIME**
					TOTAL:	AVERAGE	9.83	2.20
						STAND. DEV.	8.31	1.08
					REJECTS:	AVERAGE	8.24	0.80
						STAND. DEV.	9.13	0.93
					ACCEPTS:	AVERAGE	10.36	2.66
						STAND. DEV.	7.96	0.63

EMPLOYEE Premo
DATE 10-12-90
PAGE NO. 3/3
RCC MATPGB
SUBJECT Rework, time estimates
Source: Raul Garcia

TIME ESTIMATES FOR REWORK

Cause of reject	Process time (hours)			Total Time
	disassembly	repair	reassembly	
180				
vibration	3.5 ± .5	7.5 ± .5	7.0 ± .5	18 ± 1.5
instability	3.5 ± .5	6.5 ± .5	7.0 ± .5	17 ± 1.5
gear box	1.0 ± .25	7.5 ± .5	2.5 ± .5	11 ± 1.25
397				
vibration	3 ± .25	5.0 ± .25	5.0 ± .5	13 ± 1
instability	2.5 ± .50	5.0 ± .5	3.5 ± .5	11 ± 1.5
gear box	1.0 ± .25	7.5 ± .5	2.5 ± .5	11 ± 1.25

180

18 ± 1.5
17 ± 1.5
11 ± 1.25
} weighted average ≈ 16 hr ± 2 hr

397

13 ± 1.0
11 ± 1.5
11 ± 1.25
} weighted average ≈ 12 hr ± 2 hr

- Note: It must be remembered that these numbers are rough estimates of the time required for rework. However, since there is no other data available the numbers are the best that can be obtained.

DDB SECTION CODE

DDB PAGE NO. 176

ENGINEERING NOTES

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RCC ______ SUBJECT GTE Rejections

Following is a summary of information gathered on the problems with GTE rejections.

Brent Castle has been working the rejection problem for about 2 years. Mr Castle is a planner for the GTE's and has consolidated reject data for FYs 86, 87, 88 and 89 on a PC data base (DBASE I). Data was obtained from a reject log that is maintained in the GTE reassembly area. Data for FY 90 has not been antered into the PC data base and had to be obtained by inspection of the reject log.

The general consensus among those familiar with the GTE repair process appears to be that there is considerable room for improvement. Rough estimates of reject rates for FY 86-89 seem to confirm this. Engine delivery records obtained from Mr Zorita in Scheduling were used to calulate reject rates. The reject rates are extremely variable from year to year, with change's of up to 100% possible. The 397 GTE has an overall reject rate of 27% over the 4 year period and the 180 GTE has a reject rate of 16%. Rates were calculated by comparing total rejects to total deliveries. This method of calculation tends to show a higher rate than other methods. For the 180 GTE vibration problems account for apx 50% of rejects and cavity pressure problems account for about 36% of rejects. For the 397 GTE vibrations cause about 43% of the rejects and removals account for another 30%. Vibrations

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are usually caused by imbalance in compressor sections of the engines but can also be caused by imbalance in the turbine or accessory case, bad bearings, or misalignments. Cavity pressure problems are usually caused by bad seals or clogged return lines in the oil sump systems. Removals are related to performance problems of the engine. For the 397 engine, about 90% of the removals are due to low shaft horsepower. Mr. Castle attributes most of the performance problems to air flow problems caused by case misalignments and/or turbine nozzle mismatch. He believes that the case alignments are difficult to prevent because they cannot be detected through external inspection. Nozzle mismatch is caused by a modification that has been made to the compresso section of the GTE in order to improve performance. The effective area of the turbine nozzle was not changed in this modification, thus causing a mismatch in some of the engines. According to Mr. Castle it is difficult to predict the mismatch without first running the engine on the test stand. Garrett is currently working on the turbine nozzle in order to determine the proper effective area that is required to match the compressor mods.

Of the problems causing rejects on the test stand, the vibration problem is the most troublesome and presents a good opportunity to increase production through quality improvement. Almost half of the rejects for the 180 and 397 engines are

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due to vibration problems. As mentioned earlier, excessive vibration can be caused by compressor rotating assembly (CRA) inbalance, turbine inbalance, bad bearings, case misalignments, or any combination of the above. Vibrations have been a major headache for a considerable period of time according to Glen W. Hunt, who is a supervisor in final assembly. Mr. Hunt says that a considerable amount of effort has been spent trying to solve vibration problems. However, problems still persist, especially with the CRA for the 397 engine. To date, no formal report has been published detailing the work and results of the effort to solve the vibration problems. Following is a more detailed discussion of the potential causes of the excessive vibration. The information was obtained from conversations with Mr. Castle and Mr. Hunt.

<u>Compressor Rotating Assembly</u> (CRA)

Most vibration problems are caused by inbalance in the CRA's. While CRA inbalance occurs in both the 180 and 397 GTEs, the 397 CRA causes the most problems. In fact, the problem with the 397 CRA is so severe that Mr. Hunt and Mr. Castle are convinced that there is a major design flaw in the CRA. Mr Hunt claims that Garrett engines has admitted to a design flaw with the first stage compressor in the 397 GTE. The theory is that the design of the first stage assembly allows a phenomenon called "stress migration" to occur at

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operating speeds of around 42,000 RPM. This "stress migration" causes a change in geometry and creates an in balance in the CRA that did not occur previously. Before discussing this subject further, first some general information regarding the CRAs for both engines. In both engines, the CRA consists of a shaft with the first and second stages of the compressor attached. The first and second stage impellers for the 180 engine are of a one-piece design. For the 397 engine the second stage is a one piece design but the first stage is made up of an older 3 piece design. It is this three piece first stage that causes a vast majority of the problems with inbalance.

After disassembly and cleaning the shafts for the GTEs are inspected. If the shaft is damaged or out of specs it is sent for plating and grinding of those areas that require it. Because these shafts rotate at very high speeds, it is critical that the centerlines of all the surfaces remain along the axis of rotation. This is particularly critical if not all of the surfaces are to be reworked. If set up is not done correctly, it is possible that some portions of the shaft will no longer be concentric with the axis of rotation. This would be the same (in effect) as creating a crankshaft and would make it very difficult to bring the CRA into balance with out removing an excessively large amount of material from the compressor wheels. Despite the critical nature of the machining, the CRA shafts are

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not dimensionally checked after they leave the machine shop, according to Mr. Castle. In the past "bad batches" of shafts have caused vibration problems in completed engines. After machining, the shafts are rebalanced at 1800 RPM. During the balancing process material is removed from locations on the shaft that are specified on the TO until the shaft unbalance in within specs.

OPINION – The fact that "bad batches" of shafts are allowed to be assembled into completed engines is disturbing. Tighter dimensional inspection of shafts (prior to rebalancing) would help weed out the unsymmetrical shafts. In theory, it is possible to rebalance a shaft that has been machined into an unbalaned shape (unsymmetrical) but this might cause considerable problems when the compressor wheels are attatched and the CRA is rotated at high speeds. Some of the shafts appeared to have a large amount of material removed from them in order to get them within balance specs. This would seem to indicate that perhaps the shafts were machined into an unsymmetric shape and large amounts of material had to be removed in order to rebalance the shaft. I would think that a shaft that was truly symmetrical (ideal) would be balanced already. In summary, because the shaft is the very foundation of the CRA special attention should be paid to machining

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tolerances, inspection and balancing. If necessary, machining and balancing tolerances should be tightened up.

After the shafts have been balanced, they are ready for reassembly with the compressor wheels. The compressor wheels are reworked in the following way. After disassembly and cleaning they are inspected. Any nicks and burrs are removed by grinding and polishing. Second stage wheels are rebalanced individually prior to reassembly onto the shaft. It is not possible to balance the entire CRA with the second stage attached because disassembly would be required prior to installation in the engine. Because the 2nd stage is attached with a press fit, removing it might cause damage to the shaft that would require remachining and rebalancing.

Because the 397 CRA is the most troublesome, the following applys to it specifically. The first stage compressor for the 397 is made up of a sandwich of 3 parts: one wheel and two inducers. All three components are made of titanium. The center portion of the sandwich, the wheel, is fairly massive and contains vanes extending out radially from the center. The outer portions of the sandwich, the inducers, are less massive and contain vanes in their centers. In operation, the inducers draw air in axially from each side of the compressor and the wheel compresses the air and ejects it radially. The air is then channeled through ducts to

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to the second stage of the compressor. The three components of the 1st stage are designed to be a matched set. An attempt is made to keep the 3 pieces together. After the engine is disassembled the matched set is held together with a long bolt and wing nut. It is then sent to cleaning and inspection. After inspection of each component, the matched set is then sent for rework if it is required. At this stage, the inducer vanes are ground and polished to remove nicks and burrs caused by ingested particles. This rework is likely to create a slight inbalance in the inducers that has to be corrected in later balancing. The wheel portion of the 1st stage seldom needs rework at this stage. After any required work is done the three components are then sent to final assembly. Although the compressor arrives at the final assembly area as a set, there is no guarantee that somewhere in the rework process they were not mixed with other compressor components. In addition to this, there is a potential problem related to the relative orientation of the components with each other. Because the parts where originally balanced as a set, changing the relative angular position of the parts might make rebalancing more difficult by requiring the removal of excess amounts of material. At present there is no procedure to keep the orientation of the parts the same as they were prior to disassembly. Also there is no procedure or marking system that would

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assure that the three components of the 1st stage compressor set remain matched. Prior to final assembly no attempt is made to balance the components of the 1st stage compressor individually (the second stage is balanced individually prior to assembly).

Final assembly proceeds as follows: Inducers are matched up the the wheel by identifying the orientation that best minimizes the mismatch between vanes. This step is highly subjective and based upon the craftman's best judgement of the alignment. It is possible that the final orientation of the parts will be different than that prior to disassembly because of the subjectivity in chosing the orientation the minimizes the average mismatch between vanes. Once the inducers are matched to the wheel, the group is placed in a clamp that precompresses them and they are slid onto the splines of the compressor shaft. Epoxy is poured into the gaps between the splines. A nut is placed on the shaft and tightened to a specified torque. The clamp is removed and the CRA assembly is baked for a period of time in order to speed the curing of the epoxy. Apparently, the epoxy is used to prevent the movement of the components on the shaft when the CRA is rotated at GTE operating speeds. It is believed that the movement of the components on the shaft is sufficient to create an inbalance and rejection of the engine in final test. Possible movement of the components on the splines doesn't appear to be more than 1 or 2 degrees at the

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most. After the shaft is removed from the oven and cooled, it is ready for balancing.

Balancing of the CRA is done on a Hofmann spin balancer. The machine is basically automatic in operation and is preprogramed. The mechanic places the CRA on teflon taped bearings on the balancer. The CRA is held in place by the drive belt which pulls down with a constant preload. The CRA is rotated at 1,800 RPM and inbalance results are automatically displayed on a CRT display. Unbalance at each bearing is given at a resolution of .0001 ounce, and the angular position of the inbalance for each bearing is displayed to the nearest degree. Angular positions are given relative to a piece of reflective tape that is placed on the CRA shaft prior to balancing. The TO's covering the balancing process specify the maximum allowable magnitude of inbalance for each end of the shaft. For the 397 CRA the tolerances are .002 ounce for one end and .006 for the other. However, the craftsmen are consistantly able to reduce the inbalance to 1/3 of the maximum allowed. In fact, they are able to balance the CRA to the point where the balancing machine is unable to consistantly specify the angular position of the inbalance. In order to balance the CRA material is removed from outer edges of the wheel and inducer. Rough balancing is done by grinding areas of the more massive wheel. Balance is fine tuned by grinding the outer edges of the inducers. The TO governing the balancing process specified where and how

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much material can be removed from the wheel and inducers. If the part cannot be brought into balance by grinding to the specified limits the part is scrapped. Many parts appear to have had a large amount of material removed from their outer edges. The amount removed from the inducers seems excessively large considering the much smaller amount of material that is removed by grinding the damage to the vanes.

Despite the extreme care taken by the craftman when balancing the CRA's it is not rare for a CRA to reject 2 or 3 times due to high vibration on the test stand. Mr. Hunt believes that something is physically changing during the process of running the engine on the test stand and causing an imbalance. This is the phenomenon he described as "stress migration", and is caused by an inherent design flaw in the 1st stage (three piece design instead of a more modern one piece cast design). There appears to be a consensus among some that there is no "cure" for the problem and that they must accept it (keep rebalancing the CRA's until it finally passes on the test stand).

In addition to vibration problems that are caused by the CRA, misalignments and bad bearings also cause some rejections. Misalignments can be caused machining tolerance buildups or improper assembly. A good example of this is the short stacks for the 397. Because the short stack serves as the "foundation" of the GTE, any machining

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flaws might cause misalignment of rotating assemblys, bearing binding problems and vibration. According to Mr. Castle, there is no rigorous inspection of the short stack prior to reassembly.

OPINION

Whether or not there is a design flaw in the current 397 Compressor isn't important The fact that they are failing so often is important. There is something in the process that is causing the high failure rate, and the problem just shows up most obviously in the 397 vibration rejects. Because the problem is so large it is difficult to pinpoint just one or two areas of improvement. Following is a list of potential causes and solutions to the vibration problem for the 397 CRA.

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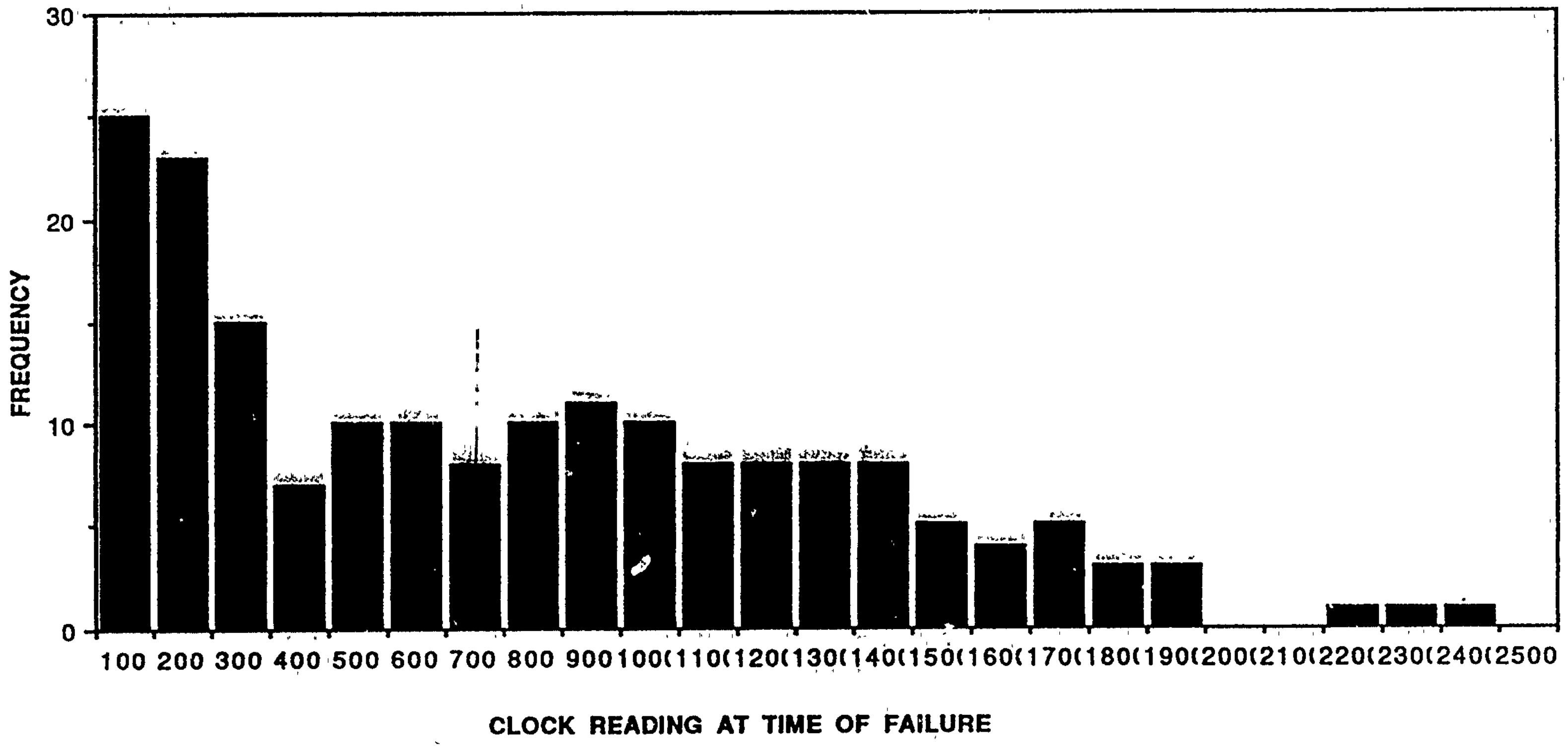
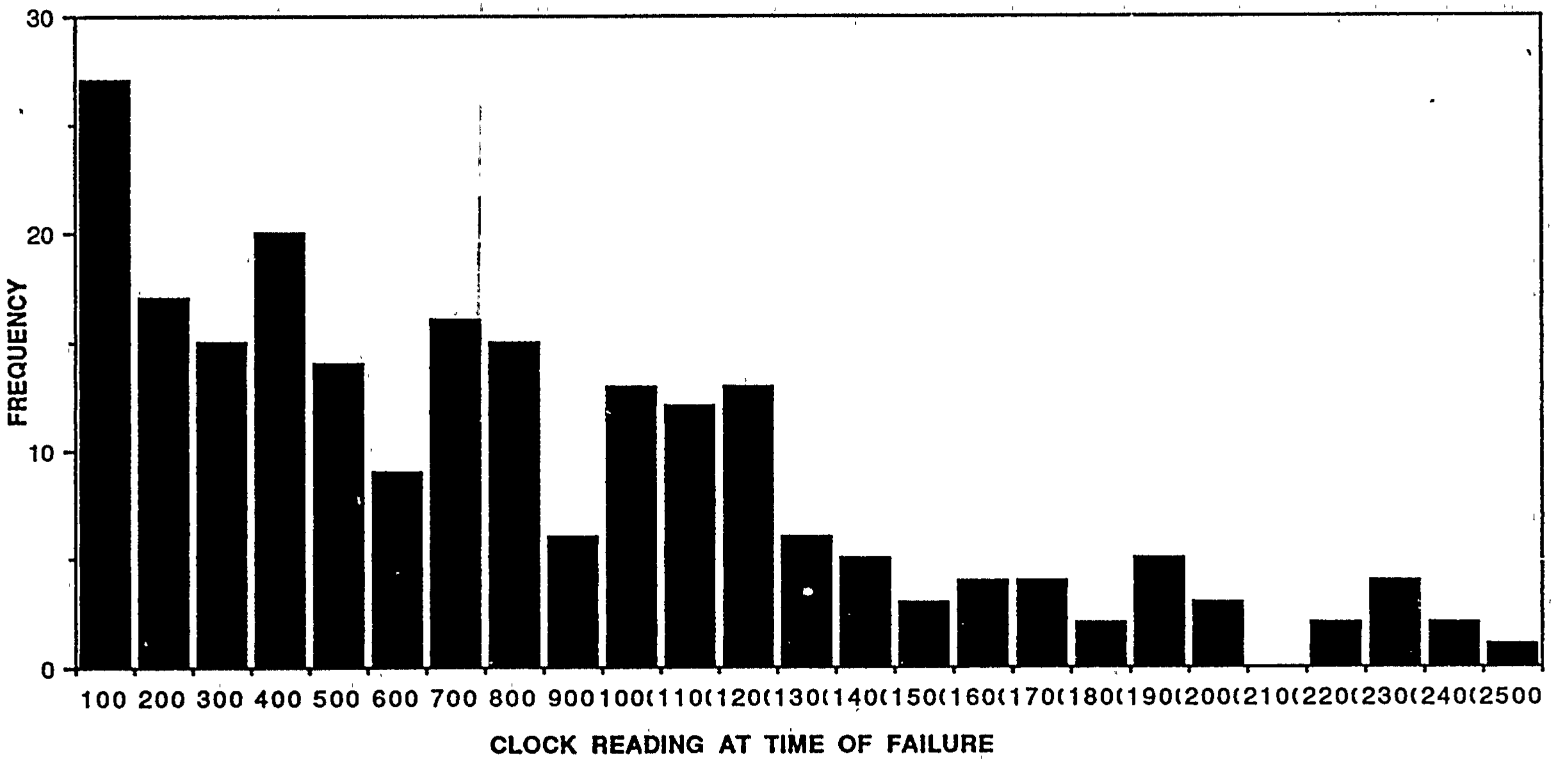
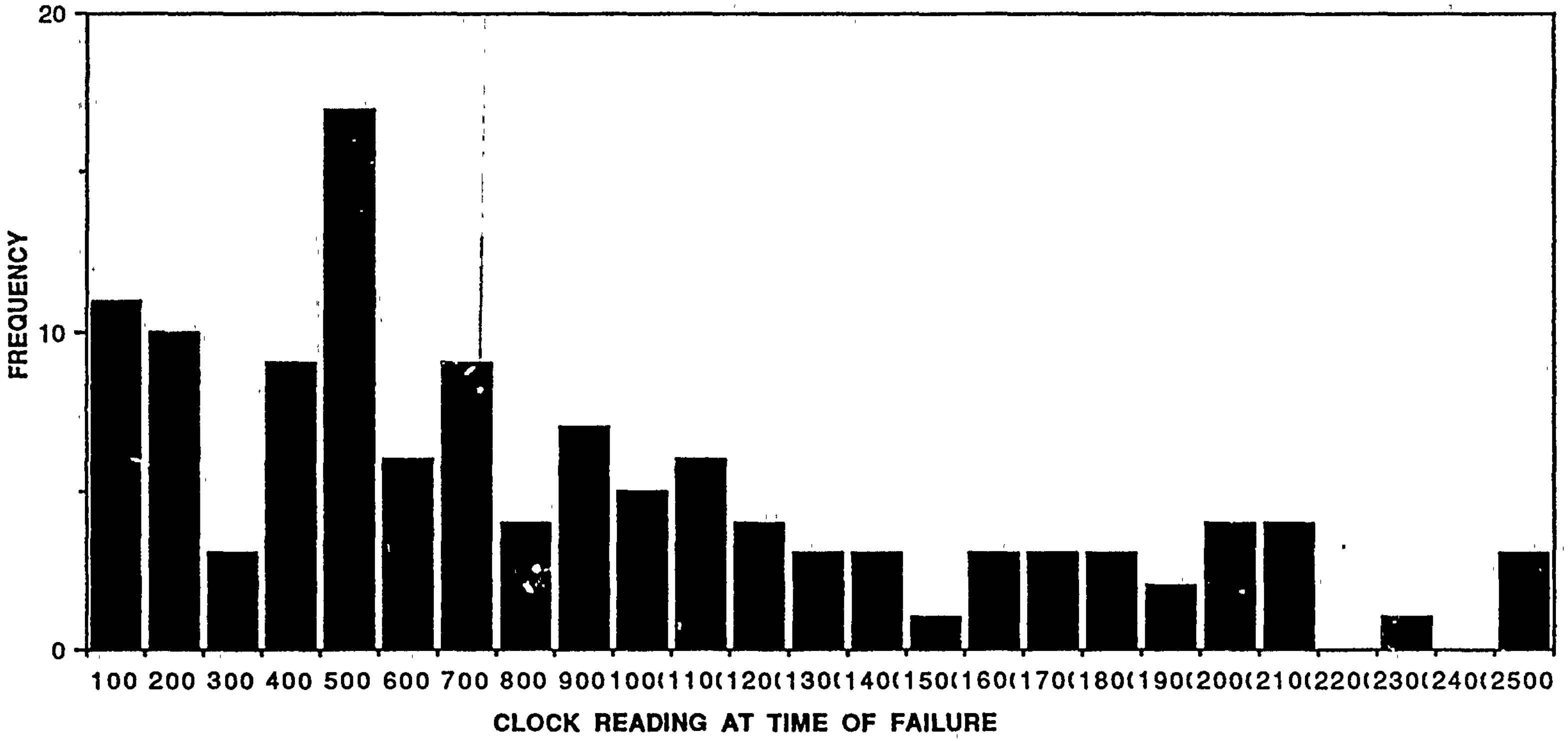


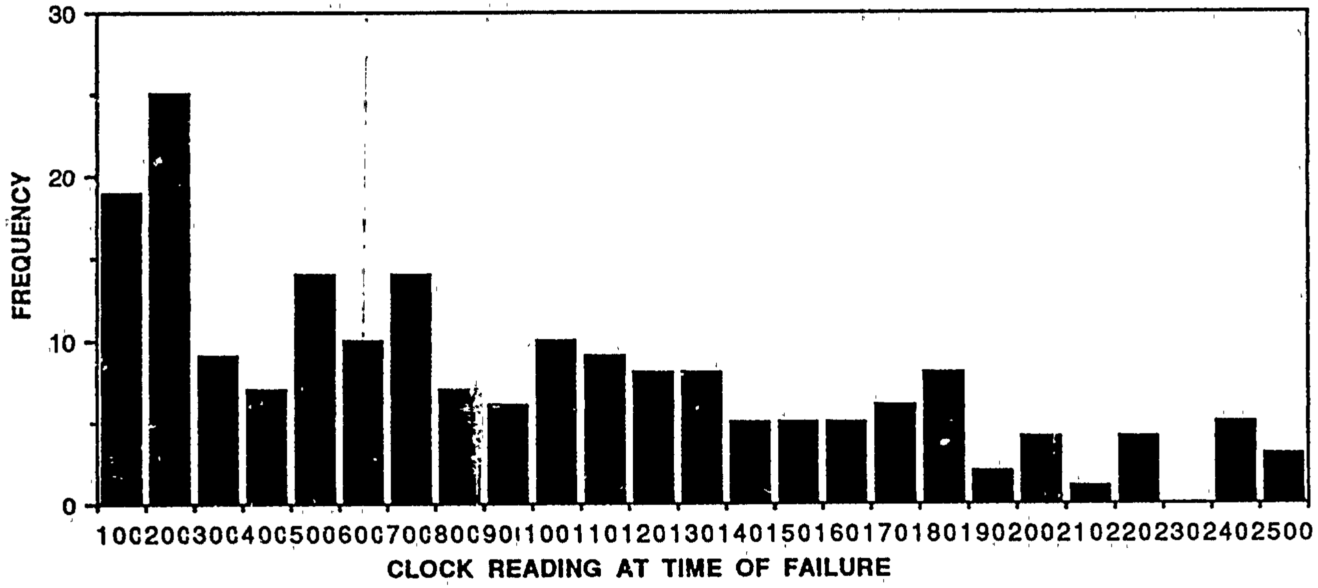
1987 -397 FIELD FAILURE DATA



1988 -397 FIELD FAILURE DATA

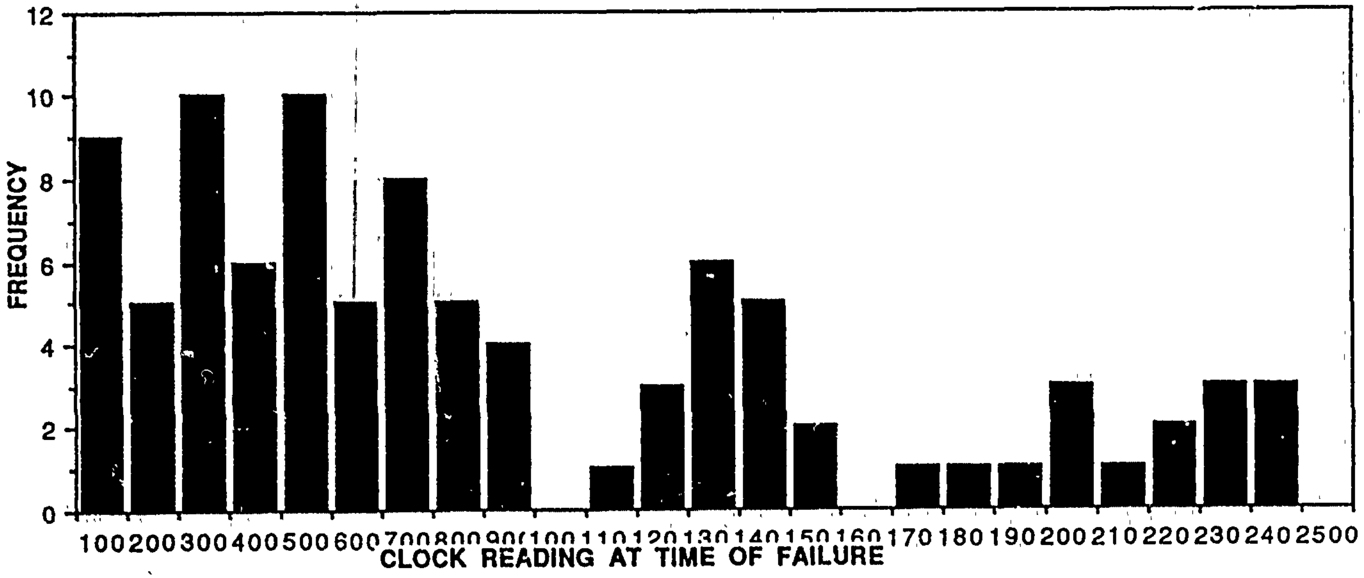


1989 -397 FIELD FAILURE DATA

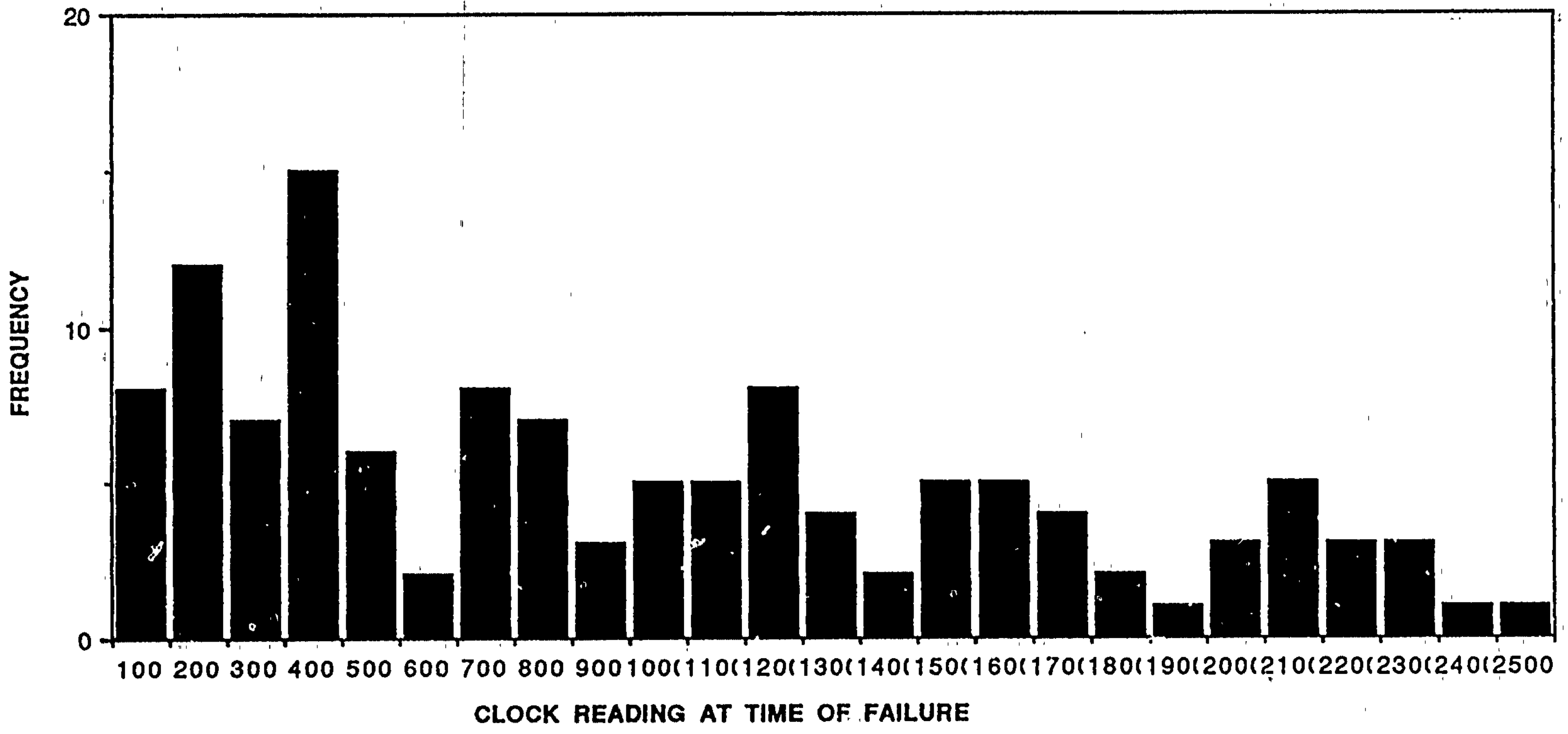


192

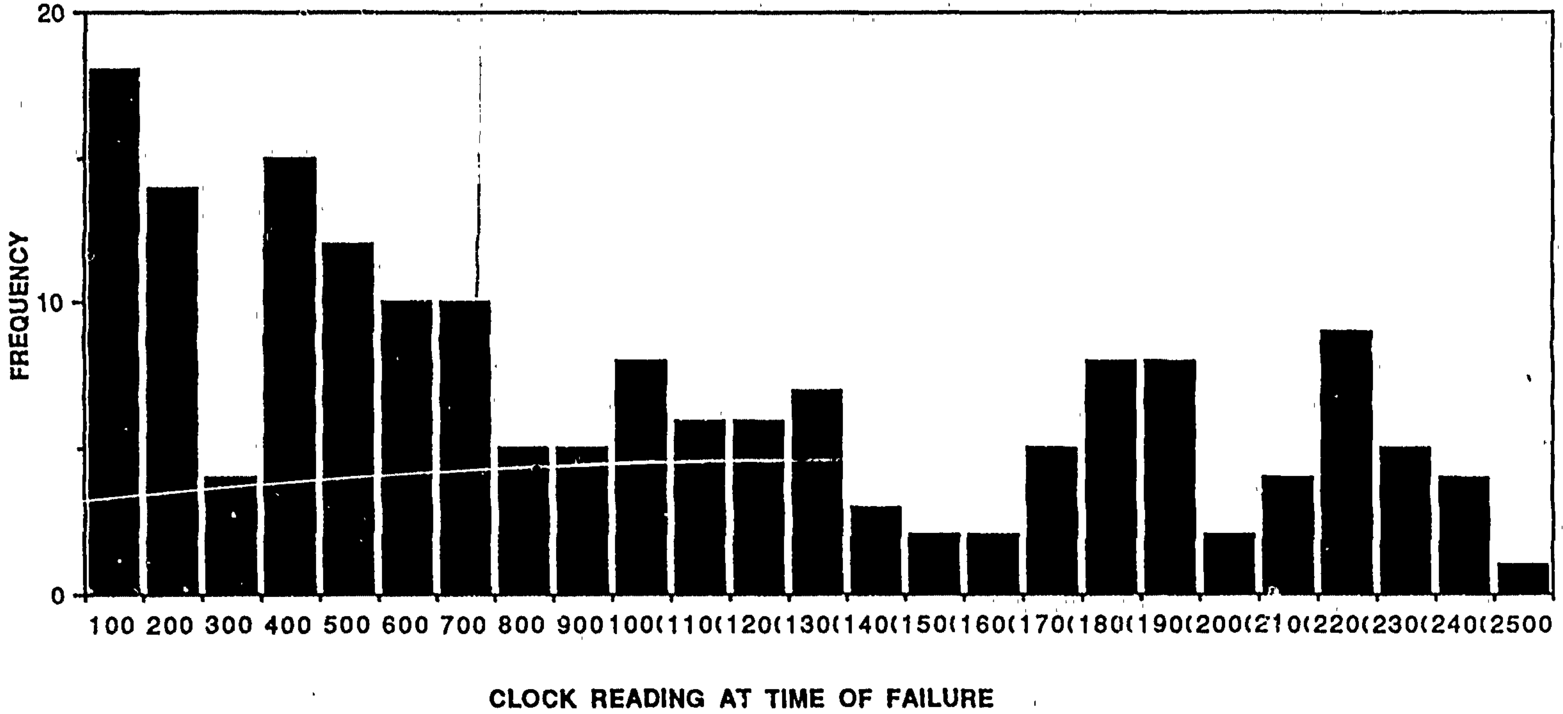
1990 -397 FEILD FAILURE DATA



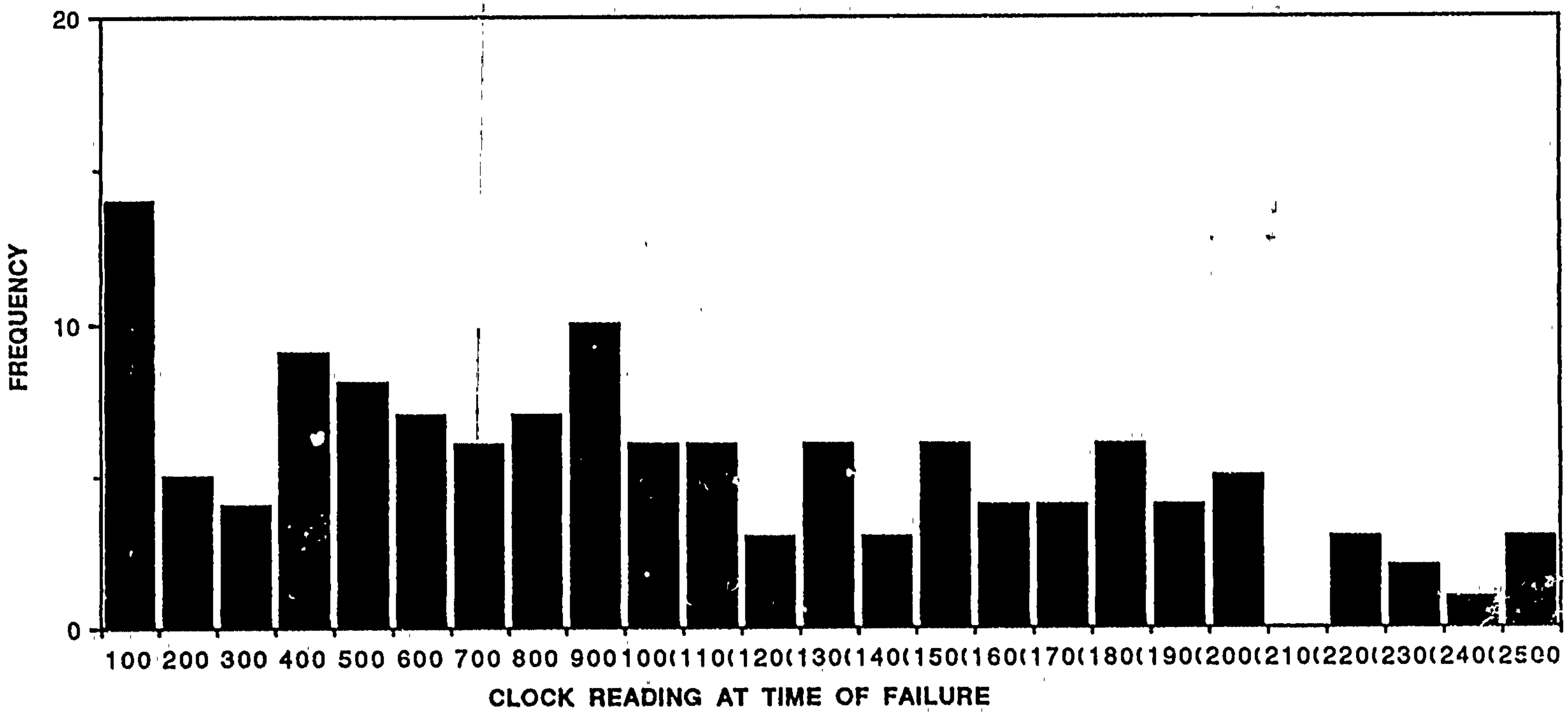
1986 -180 FIELD FAILURE DATA



1987 -180 FIELD FAILURE DATA



1988 -180 FIELD FAILURE DATA



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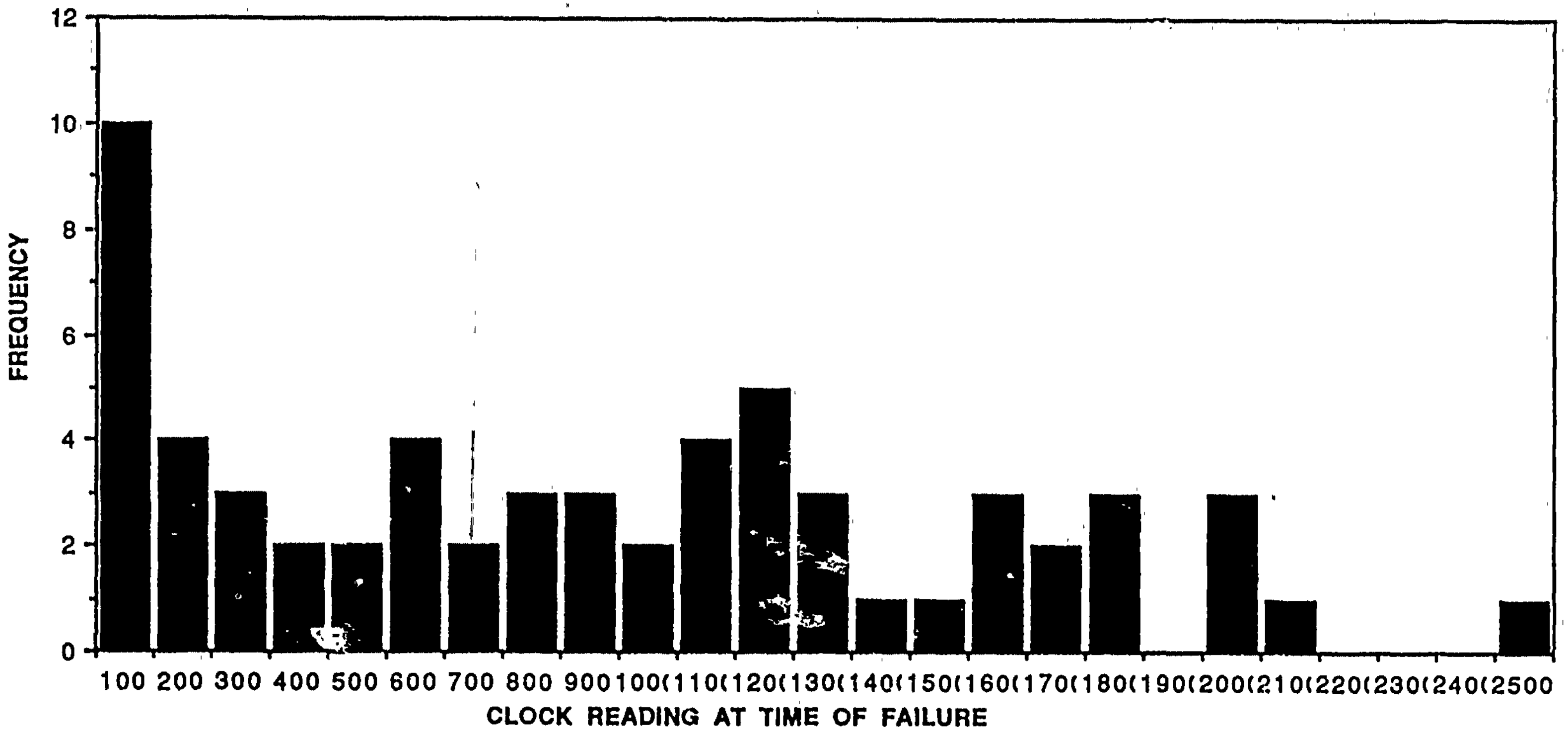

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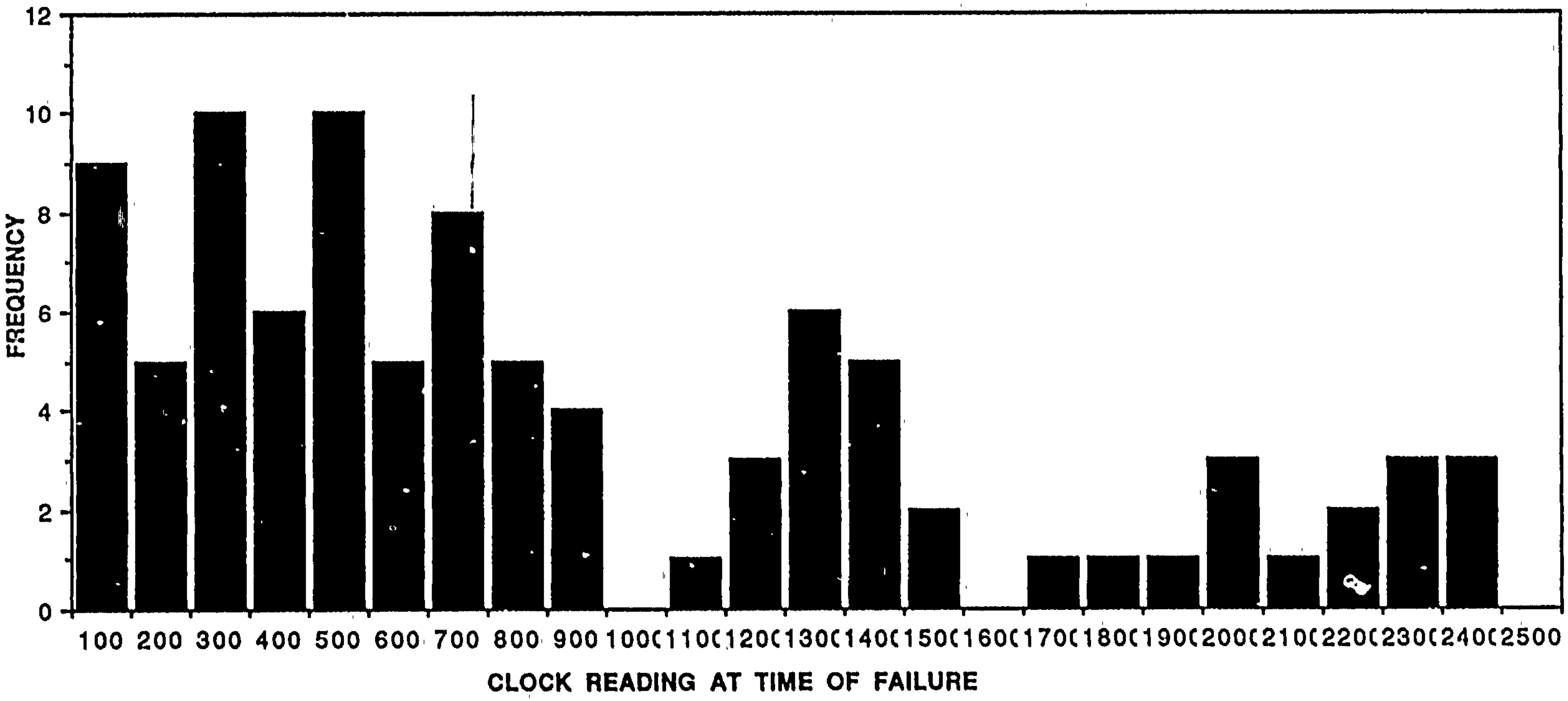

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Copy of 86 IND.

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160					397	1366
161					397	1397
162	30 ENTRIES >2500				397	1397
163	i.e. 19% >2500 hrs				397	1410
164					397	1429
165	21 entries >3000		49 entries <500		397	1440
166	i.e. 13% >3000 hrs		i.e. 31% <500 hrs		397	1453
167					397	1495
168	15 entries >4000		75 entries <1000		397	1511
169	i.e. 10% >4000 hrs		i.e. 47% <1000		397	1538
170					397	1543
171	min = 4 hrs				397	1582
172	max = 9318 hrs				397	1605
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197					8 entries >2000	
198					i.e. 4% >2000	
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200					23 entries >1500	
201					i.e. 12% >1500	
202						
203					min = 0	
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50	6070	
51	6070	
52	6072	
53	6072	
54	6072	
55	6076	
56	6076	
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59	6077	
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63	6083	
64	6083	
65	6084	
66	6093	
67	6093	
68	6093	
69	6097	
70	6097	
71	6097	
72	6097	
73	6099	
74	6099	
75	6099	
76	6111	
77	6111	
78	6111	
79	6118	
80	6118	
81	6118	
82	6119	
83	6119	
84	6120	
85	6120	
86	6120	
87	6153	
88	6153	
89	6153	
90	6153	
91	6161	
92	6161	
93	6163	
94	6163	

Copy of 86 IND.

	G	H
95	6164	
96	6169	
97	6169	
98	6169	
99	6170	
100	6171	
101	6171	
102	6174	
103	6175	
104	6175	
105	6175	
106	6175	
107	6181	
108	6181	
109	6181	
110	6183	
111	6184	
112	6184	
113	6184	
114	6189	
115	6189	
116	6190	
117	6191	
118	6197	
119	6197	
120	6212	
121	6212	
122	6212	
123	6213	
124	6213	
125	6213	
126	6218	
127	6218	
128	6221	
129	6221	
130	6227	
131	6227	
132	6227	
133	6232	
134	6232	
135	6233	
136	6234	
137	6234	
138	6245	
139	6245	
140	6245	
141	6245	

205

	G	H
142	6246	
143	6247	
144	6247	
145	6248	
146	6248	
147	6251	
148	6253	
149	6258	
150	6259	
151	6261	
152	6268	
153	6268	
154	6270	
155	6270	
156	6270	
157	6275	
158	6275	
159	6275	
160	6275	
161	6275	
162	6277	
163	6277	
164	6277	
165	6282	
166	6282	
167	6283	
168	6283	
169	6287	
170	6287	
171	6287	
172	6287	
173	6307	
174	6307	
175	6310	
176	6310	
177	6314	
178	6317	
179	6317	
180	6321	
181	6322	
182	6322	
183	6323	
184	6323	
185	6323	
186	6324	
187	6330	
188	6330	

	G	H
189	6335	
190	6335	
191	6337	
192	1762.24034	
193		
194		
195		
196		
197	81 entries <500 hrs	
198	i.e. 42% <500	
199		
200	95 entries <650	
201	i.e. 50% <650 hrs	
202		
203		
204		

Copy of 87 IND

	A	B	C	D	E	F
1	TYPE	TIME METER	JULIAN DATE		TYPE	TIME METER
2	180	0	7005		397	1
3	180	0	7005		397	4
4	180	1	7005		397	5
5	180	3	7005		397	5
6	180	4	7005		397	7
7	180	4	7008		397	8
8	180	5	7008		397	13
9	180	5	7008		397	23
10	180	7	7013		397	24
11	180	11	7015		397	25
12	180	17	7021		397	33
13	180	43	7021		397	35
14	180	48	7021		397	37
15	180	74	7027		397	40
16	180	83	7033		397	50
17	180	84	7033		397	54
18	180	94	7033		397	57
19	180	98	7033		397	58
20	180	100	7033		397	65
21	180	100	7033		397	71
22	180	101	7033		397	78
23	180	102	7033		397	79
24	180	121	7033		397	80
25	180	122	7033		397	81
26	180	134	7033		397	81
27	180	138	7041		397	90
28	180	144	7041		397	96
29	180	151	7058		397	106
30	180	166	7058		397	109
31	180	169	7058		397	124
32	180	169	7058		397	125
33	180	182	7058		397	126
34	180	205	7058		397	130
35	180	214	7063		397	143
36	180	245	7063		397	144
37	180	298	7064		397	157
38	180	300	7064		397	168
39	180	310	7064		397	178
40	180	315	7065		397	179
41	180	317	7068		397	183
42	180	317	7068		397	189
43	180	320	7068		397	190
44	180	324	7069		397	193
45	180	338	7069		397	195
46	180	342	7069		397	205
47	180	347	7069		397	205

208

	A	B	C	D	E	F
48	180	349	7070		397	206
49	180	361	7071		397	210
50	180	361	7071		397	234
51	180	393	7083		397	236
52	180	399	7083		397	240
53	180	400	7096		397	248
54	180	401	7096		397	251
55	180	413	7096		397	254
56	180	414	7098		397	264
57	180	416	7100		397	280
58	180	425	7100		397	284
59	180	433	7100		397	288
60	180	462	7104		397	297
61	180	475	7107		397	302
62	180	482	7107		397	312
63	180	484	7118		397	320
64	180	492	7121		397	326
65	180	515	7124		397	351
66	180	516	7125		397	351
67	180	518	7127		397	358
68	180	522	7132		397	361
69	180	540	7132		397	361
70	180	548	7132		397	363
71	180	563	7132		397	369
72	180	565	7132		397	369
73	180	566	7155		397	370
74	180	572	7155		397	373
75	180	621	7155		397	383
76	180	621	7156		397	383
77	180	623	7156		397	383
78	180	628	7160		397	386
79	180	633	7160		397	391
80	180	639	7160		397	396
81	180	645	7160		397	416
82	180	647	7161		397	420
83	180	674	7161		397	424
84	180	694	7161		397	425
85	180	713	7161		397	434
86	180	722	7161		397	442
87	180	743	7162		397	464
88	180	747	7170		397	473
89	180	790	7170		397	476
90	180	808	7182		397	487
91	180	817	7182		397	489
92	180	833	7182		397	493
93	180	837	7182		397	499
94	180	840	7182		397	499

	A	B	C	D	E	F
95	180	924	7182		397	504
96	180	952	7182		397	554
97	180	959	7183		397	566
98	180	981	7187		397	578
99	180	988	7187		397	583
100	180	988	7188		397	588
101	180	989	7196		397	589
102	180	993	7196		397	594
103	180	1000	7196		397	598
104	180	1024	7202		397	609
105	180	1026	7203		397	611
106	180	1058	7203		397	612
107	180	1065	7204		397	614
108	180	1082	7204		397	618
109	180	1101	7205		397	623
110	180	1121	7205		397	640
111	180	1147	7205		397	640
112	180	1148	7209		397	648
113	180	1173	7213		397	651
114	180	1196	7213		397	660
115	180	1241	7213		397	679
116	180	1243	7214		397	679
117	180	1246	7217		397	681
118	180	1287	7217		397	687
119	180	1289	7219		397	697
120	180	1290	7219		397	711
121	180	1293	7219		397	721
122	180	1343	7223		397	724
123	180	1347	7224		397	730
124	180	1349	7224		397	732
125	180	1417	7224		397	748
126	180	1468	7226		397	749
127	180	1503	7226		397	754
128	180	1552	7226		397	757
129	180	1601	7231		397	759
130	180	1602	7231		397	759
131	180	1611	7236		397	771
132	180	1643	7236		397	772
133	180	1681	7237		397	785
134	180	1724	7238		397	789
135	180	1730	7240		397	845
136	180	1741	7240		397	846
137	180	1748	7245		397	851
138	180	1752	7245		397	852
139	180	1768	7247		397	867
140	180	1772	7251		397	881
141	180	1794	7257		397	914

	A	B	C	D	E	F
142	180	1802	7258		397	915
143	180	1828	7265		397	921
144	180	1831	7265		397	934
145	180	1847	7265		397	938
146	180	1868	7266		397	943
147	180	1872	7266		397	953
148	180	1889	7266		397	968
149	180	1892	7274		397	973
150	180	1962	7274		397	974
151	180	1992	7274		397	986
152	180	2014	7278		397	990
153	180	2030	7278		397	999
154	180	2042	7278		397	1003
155	180	2086	7279		397	1023
156	180	2109	7280		397	1029
157	180	2109	7280		397	1033
158	180	2109	7280		397	1041
159	180	2112	7281		397	1054
160	180	2163	7286		397	1054
161	180	2179	7288		397	1082
162	180	2184	7292		397	1090
163	180	2187	7292		397	1095
164	180	2187	7293		397	1095
165	180	2212	7293		397	1099
166	180	2215	7294		397	1101
167	180	2253	7295		397	1114
168	180	2261	7295		397	1133
169	180	2270	7295		397	1134
170	180	2300	7295		397	1136
171	180	2332	7295		397	1138
172	180	2348	7296		397	1151
173	180	2363	7296		397	1159
174	180	2475	7296		397	1164
175	180	2583	7306		397	1178
176	180	2598	7306		397	1186
177	180	2687	7306		397	1195
178	180	2778	7306		397	1198
179	180	2798	7307		397	1203
180	180	2814	7307		397	1232
181	180	2842	7308		397	1233
182	180	2867	7308		397	1234
183	180	2870	7308		397	1242
184	180	2871	7309		397	1249
185	180	2966	7309		397	1309
186	180	2993	7309		397	1326
187	180	3084	7309		397	1376
188	180	3090	7314		397	1397

	A	B	C	D	E	F
189	180	3091	7314		397	1398
190	180	3229	7314		397	1413
191	180	3382	7321		397	1476
192	180	3384	7324		397	1488
193	180	3386	7324		397	1523
194	180	3392	7324		397	1541
195	180	3441	7326		397	1553
196	180	3612	7326		397	1578
197	180	3649	7326		397	1603
198	180	3863	7326		397	1627
199	180	4044	7328		397	1645
200	180	4050	7328		397	1661
201	180	4165	7328		397	1713
202	180	4288	7328		397	1764
203	180	4361	7329		397	1809
204	180	4422	7335		397	1817
205	180	4863	7335		397	1819
206	180	4992	7335		397	1833
207	180	5395	7335		397	1881
208	180	5583	7335		397	1952
209	180	6230	7335		397	1965
210	180	6290	7337		397	1994
211	180	7859	7338		397	2167
212		1455.29762	1372.87894		397	2191
213					397	2203
214	36 ENTRIES >2500		64 entries <500		397	2246
215	i.e. 17% >2500		i.e. 30% <500hrs		397	2251
216					397	2256
217	24 entries >3000		102 entries <1000		397	2306
218	i.e. 11% >3000 hrs		i.e. 48% <1000hrs		397	2313
219					397	2467
220					397	2550
221	min = 0				397	2765
222	max = 7859				397	2813
223					397	3123
224					397	3200
225					397	4410
226						813.816518
227						
228						6 entries >25
229						i.e 3% >2500
230						
231						71 entries >1
232						i.e 32% >100
233						
234						min = 1
235						max = 4410

	G	H	I
1	JULIAN DATE		
2	7005		
3	7005		
4	7005		
5	7006		
6	7009		
7	7012		
8	7012		
9	7012		
10	7012		
11	7016		
12	7016		
13	7026		
14	7026		
15	7033		
16	7033		
17	7048		
18	7048		
19	7048		
20	7048		
21	7050		
22	7050		
23	7050		
24	7050		
25	7051		
26	7051		
27	7051		
28	7051		
29	7052		
30	7052		
31	7052		
32	7052		
33	7052		
34	7052		
35	7063		
36	7063		
37	7065		
38	7065		
39	7065		
40	7090		
41	7090		
42	7091		
43	7091		
44	7098		
45	7098		
46	7098		
47	7098		

	G	H	I
48	7100		
49	7100		
50	7100		
51	7103		
52	7103		
53	7121		
54	7121		
55	7127		
56	7127		
57	7127		
58	7127		
59	7132		
60	7147		
61	7147		
62	7147		
63	7147		
64	7148		
65	7148		
66	7152		
67	7152		
68	7152		
69	7152		
70	7155		
71	7155		
72	7156		
73	7162		
74	7166		
75	7166		
76	7182		
77	7182		
78	7182		
79	7182		
80	7182		
81	7182		
82	7183		
83	7183		
84	7183		
85	7183		
86	7189		
87	7189		
88	7189		
89	7189		
90	7195		
91	7195		
92	7196		
93	7196		
94	7198		

	G	H	I
95	7201		
96	7201		
97	7202		
98	7202		
99	7204		
100	7204		
101	7204		
102	7204		
103	7213		
104	7213		
105	7214		
106	7214		
107	7218		
108	7218		
109	7218		
110	7219		
111	7219		
112	7219		
113	7219		
114	7225		
115	7225		
116	7225		
117	7229		
118	7229		
119	7231		
120	7231		
121	7233		
122	7233		
123	7239		
124	7239		
125	7239		
126	7240		
127	7240		
128	7240		
129	7245		
130	7245		
131	7245		
132	7246		
133	7246		
134	7246		
135	7253		
136	7253		
137	7254		
138	7258		
139	7258		
140	7258		
141	7261		

215

	G	H	I
142	7261		
143	7265		
144	7265		
145	7266		
146	7266		
147	7274		
148	7274		
149	7274		
150	7274		
151	7275		
152	7279		
153	7279		
154	7279		
155	7279		
156	7279		
157	7281		
158	7282		
159	7282		
160	7282		
161	7282		
162	7287		
163	7287		
164	7292		
165	7292		
166	7293		
167	7293		
168	7294		
169	7294		
170	7294		
171	7294		
172	7294		
173	7306		
174	7306		
175	7306		
176	7321		
177	7322		
178	7322		
179	7323		
180	7323		
181	7323		
182	7323		
183	7323		
184	7323		
185	7324		
186	7324		
187	7324		
188	7326		

	G	H	I
189	7326		
190	7326		
191	7326		
192	7326		
193	7326		
194	7329		
195	7329		
196	7334		
197	7337		
198	7341		
199	7341		
200	7341		
201	7341		
202	7341		
203	7341		
204	7342		
205	7342		
206	7342		
207	7342		
208	7342		
209	7343		
210	7343		
211	7344		
212	7344		
213	7344		
214	7345		
215	7345		
216	7348		
217	7348		
218	734		
219	7349		
220	7350		
221	7350		
222	7350		
223	7351		
224	7351		
225	/352		
226	705.871369		
227			
228	00	94 entries <500	
229		i.e. 42% <500hrs	
230			
231	000	112 entries <650	
232	hrs	i.e. 50% <650 hrs	
233			
234			
235			

COPY OF 88 IND

	A	B	C	D	E	F
1	TYPE	TIME METER	JULIAN DATE		TYPE	TIME METER
2	180	2	8004		397	0.7
3	180	3	8004		397	2.6
4	180	5	8014		397	3.7
5	180	6	8019		397	7.6
6	180	9	8019		397	11.4
7	180	12	8022		397	19.6
8	180	20	8022		397	21.8
9	180	39	8027		397	29
10	180	45	8028		397	29.2
11	180	58	8032		397	45
12	180	60	8035		397	74.4
13	180	63	8040		397	101.8
14	180	77	8041		397	114.1
15	180	81	8041		397	116.5
16	180	100	8042		397	128
17	180	152	8042		397	140.8
18	180	153	8048		397	145.2
19	180	161	8049		397	153.7
20	180	169	8053		397	181.8
21	180	226	8055		397	186.2
22	180	227			397	188.2
23	180	229	8061		397	219.2
24	180	233	8061		397	248
25	180	304	8064		397	292.5
26	180	313	8068		397	300.3
27	180	325	8070		397	313.6
28	180	337	8071		397	327.4
29	180	338	8075		397	348.3
30	180	353	8077		397	354.6
31	180	359	8078		397	362.9
32	180	381	8082		397	367.2
33	180	398	8084		397	368.7
34	180	429	8089		397	368.7
35	180	435	8090		397	404.5
36	180	456	8091		397	409.6
37	180	470	8092		397	409.9
38	180	483	8096		397	413.9
39	180	486	8097		397	418.2
40	180	491	8097		397	424.4
41	180	499	8099		397	425.2
42	180	500	8012		397	429.9
43	180	505	8104		397	446
44	180	512	8105		397	455.6
45	180	535	8109		397	455.6
46	180	558	8110		397	457.9
47	180	591	8112		397	467.8

COPY OF 88 IND

	A	B	C	D	E	F
48	180	598	8113		397	468.8
49	180	659	8113		397	481.5
50	180	662	8118		397	485.3
51	180	664	8120		397	492.3
52	180	667	8124		397	499.8
53	180	680	8124		397	534.3
54	180	691	8125		397	567.4
55	180	712	8127		397	575
56	180	716	8130		397	593.1
57	180	746	8130		397	598.7
58	180	747	8131		397	607.2
59	180	773	8132		397	611.5
60	180	777	8134		397	614.4
61	180	792	8137		397	617.6
62	180	800	8137		397	635
63	180	800	8139		397	645.7
64	180	813	8139		397	649.4
65	180	849	8140		397	682.3
66	180	850	8144		397	690.2
67	180	852	8144		397	717
68	180	863	8146		397	733.7
69	180	863	8147		397	755.6
70	180	893	8152		397	756.6
71	180	897	8153		397	818.3
72	180	903	8154		397	827.2
73	180	920	8154		397	827.9
74	180	931	8154		397	834
75	180	938	8154		397	846.2
76	180	960	8154		397	854
77	180	999	8154		397	858.1
78	180	1002	8155		397	926
79	180	1006	8159		397	944.1
80	180	1023	8160		397	965
81	180	1048	8161		397	982.5
82	180	1074	8161		397	998.2
83	180	1099	8165		397	1001.3
84	180	1142	8166		397	1018.4
85	180	1144	8167		397	1021.6
86	180	1193	8167		397	1025.5
87	180	1202	8168		397	1054.6
88	180	1220	8169		397	1066.6
89	180	1239	8172		397	1112.7
90	180	1273	8175		397	1144.8
91	180	1276	8179		397	1159.3
92	180	1285	8180		397	1192
93	180	1341	8182		397	1229.1
94	180	1353	8183		397	1276.9

	A	B	C	D	E	F
95	180	1371	8187		397	1294.9
96	180	1412	8188		397	1307.4
97	180	1414	8190		397	1364.3
98	180	1425	8190		397	1396.8
99	180	1429	8193		397	1433.7
100	180	1434	8194		397	1571.8
101	180	1461	8195		397	1580.7
102	180	1532	8197		397	1596.2
103	180	1540	8200		397	1636.9
104	180	1541	8202		397	1679
105	180	1575	8204		397	1690.3
106	180	1645	8207		397	1731.7
107	180	1659	8208		397	1739.2
108	180	1671	8209		397	1754.4
109	180	1675	8210		397	1801.4
110	180	1727	8211		397	1846.1
111	180	1737	8214		397	1923.9
112	180	1750	8215		397	1934.9
113	180	1771	8216		397	1944.2
114	180	1778	8217		397	1994.6
115	180	1795	8221		397	2085.7
116	180	1856	8222		397	2087.2
117	180	1859	8223		397	2087.3
118	180	1875	8223		397	2094.7
119	180	1885	8224		397	2243.6
120	180	1930	8225		397	2412.8
121	180	1945	8228		397	2422
122	180	1955	8229		397	2453.4
123	180	1990	8230		397	2589.9
124	180	1996	8231		397	2637
125	180	2112	8231		397	2791.7
126	180	2158	8232		397	3176
127	180	2158	8235			891.9328
128	180	2256	8236			
129	180	2295	8237		44 entries >1000	
130	180	2311	8238		i.e. 35% >1000hrs	
131	180	2420	8239			
132	180	2440	8242			
133	180	2450	8243			
134	180	2559	8244			
135	180	2559	8250		min = 0.7	
136	180	2585	8251		max = 3176	
137	180	2638	8252			
138	180	2682	8252			
139	180	2695	8257			
140	180	2741	8258			
141	180	2755	8258			

	A	B	C	D	E	F
142	180	2771	8259			
143	180	2798	8259			
144	180	2810	8259			
145	180	2917	8263			
146	180	2939	8263			
147	180	3049	8263			
148	180	3059	8264			
149	180	3074	8264			
150	180	3083	8267			
151	180	3122	8267			
152	180	3141	8267			
153	180	3176	8270			
154	180	3198	8271			
155	180	3216	8274			
156	180	3365	8277			
157	180	3399	8278			
158	180	3465	8279			
159	180	3491	8280			
160	180	3646	8281			
161	180	3869	8281			
162	180	4111	8285			
163	180	4197	8286			
164	180	4652	8287			
165	180	4772	8291			
166	180	5279	8291			
167	180	5434	8298			
168	180	5472	8307			
169	180	5555	8309			
170	180	7101	8313			
171	180	9455	8319			
172	180	14025	8321			
173		1650.29123	1731.79386			
174						
175						
176	38 entries >2500		77 entries <1000			
177	i.e. 22% >2500hrs		i.e. 45% <1000hrs			
178						
179	95 entries >1000		41 entries <500			
180	i.e. 55% >1000 hrs		i.e. 24% <500			
181						
182	min = 2					
183	max = 14025					

	G	H
1	JULIAN DATE	
2	8004	
3	8004	
4	8004	
5	8013	
6	8013	
7	8022	
8	8026	
9	8029	
10	8033	
11	8035	
12	8040	
13	8041	
14	8041	
15	8053	
16	8054	
17	8057	
18	8062	
19	8064	
20	8068	
21	8071	
22	8076	
23	8077	
24	8083	
25	8085	
26	8089	
27	8090	
28	8092	
29	8095	
30	8104	
31	8109	
32	8110	
33	8111	
34	8116	
35	8117	
36	8119	
37	8124	
38	8127	
39	8130	
40	8132	
41	8137	
42	8139	
43	8145	
44	8146	
45	8148	
46	8152	
47	8159	

	G	H
48	8161	
49	8166	
50	8169	
51	8173	
52	8175	
53	8181	
54	8183	
55	8188	
56	8190	
57	8197	
58	8200	
59	8203	
60	8208	
61	8215	
62	8221	
63	8222	
64	8224	
65	8230	
66	8235	
67	8236	
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69	8239	
70	8243	
71	8244	
72	8250	
73	8251	
74	8257	
75	8257	
76	8257	
77	8278	
78	8279	
79	8280	
80	8281	
81	8285	
82	8286	
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84	8291	
85	8291	
86	8295	
87	8298	
88	8305	
89	8305	
90	8306	
91	8306	
92	8306	
93	8319	
94	8321	

	G	H
95	8321	
96	8323	
97	8323	
98	8326	
99	8326	
100	8327	
101	8327	
102	8333	
103	8335	
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105	8336	
106	8336	
107	8336	
108	8340	
109	8340	
110	8340	
111	8347	
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115	8347	
116	8347	
117	8347	
118	8348	
119	8348	
120	8349	
121	8349	
122	8349	
123	8349	
124	8349	
125	8349	
126	8350	
127	726.366408	
128		
129	52 entries <500	
130	i.e. 41% <500 hrs	
131		
132	64 entries <650	
133	i.e. 51% <650 hrs	
134		
135		
136		
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	A	B	C	D	E	F
1	TYPE	TIME METER	JULIAN DATE		TYPE	TIME METER
2	180	2.3	9012		397	0.3
3	180	2.4	9012		397	0.8
4	180	2.7	9012		397	2.2
5	180	4.6	9019		397	2.8
6	180	5.3	9025		397	3.5
7	180	6.7	9030		397	12.2
8	180	40.3	9032		397	20.4
9	180	78.7	9032		397	24.7
10	180	94.5	9032		397	39.6
11	180	99.4	9034		397	43.1
12	180	102.3	9034		397	47.8
13	180	116.8	9037		397	52
14	180	127.7	9047		397	52.4
15	180	187.3	9047		397	53
16	180	255	9062		397	57.3
17	180	268.2	9066		397	60.3
18	180	284.7	9079		397	66.9
19	180	349.2	9080		397	74.2
20	180	363.7	9086		397	91
21	180	464	9087		397	99.9
22	180	486	9087		397	100.7
23	180	507.6	9089		397	101.5
24	180	512.9	9089		397	102.5
25	180	563	9096		397	106.8
26	180	589.6	9096		397	106.9
27	180	605.6	9096		397	108.2
28	180	661.5	9096		397	109.7
29	180	735.9	9097		397	117
30	180	740	9097		397	127.4
31	180	767	9101		397	129.9
32	180	831	9102		397	139.9
33	180	871.5	9104		397	140
34	180	887.4	9104		397	143.4
35	180	918.4	9115		397	145.3
36	180	927	9116		397	148.4
37	180	1002	9116		397	161.2
38	180	1024	9118		397	164.1
39	180	1083.7	9118		397	171
40	180	1089.4	9118		397	177.3
41	180	1101.4	9117		397	186.4
42	180	1111.5	9119		397	188
43	180	1112.7	9119		397	188.7
44	180	1136.1	9119		397	192.7
45	180	1143.6	9119		397	193.5
46	180	1235.7	9122		397	215.1
47	180	1250.1	9122		397	217.7

	A	B	C	D	E	F
48	180	1281	9123		397	223.7
49	180	1331	9123		397	230.3
50	180	1456	9125		397	236.5
51	180	1501	9130		397	240.2
52	180	1518.7	9130		397	246.2
53	180	1562.2	9136		397	289.5
54	180	1613	9138		397	290.2
55	180	1664.2	9145		397	300
56	180	1700	9147		397	324.6
57	180	1720	9147		397	326.2
58	180	1731.6	9147		397	347.2
59	180	1907.1	9153		397	356.6
60	180	1964.1	9157		397	375
61	180	1991.2	9157		397	391
62	180	2072.9	9160		397	399.7
63	180	2414.8	9165		397	405.7
64	180	2529	9168		397	420.6
65	180	2643.9	9201		397	422
66	180	2799	9201		397	434.8
67	180	2914	9201		397	441.8
68	180	2942	9201		397	445.4
69	180	2964.9	9201		397	447.9
70	180	2997.9	9201		397	450.8
71	180	3125	9202		397	451.8
72	180	3235	9206		397	463.7
73	180	3444.6	9207		397	489
74	180	3650	9209		397	489.9
75	180	3959	9223		397	497.5
76	180	4174.7	9249		397	509.4
77	180	4192	9249		397	518.9
78	180	4241.5	9257		397	548.7
79	180	4331.7	9258		397	549.2
80	180	4375.4	9258		397	549.8
81	180	4428.8	9263		397	552
82	180	4463	9263		397	564
83	180	4564	9278		397	564.5
84	180	4834.6	9278		397	576.1
85	180	4911.2	9286		397	585
86	180	5093.2	9286		397	600.8
87	180	5096.6	9292		397	618.6
88	180	5152	9294		397	621.2
89	180	5183	9299		397	626.3
90	180	5193	9303		397	627.3
91	180	5370	9306		397	627.6
92	180	5810	9306		397	634.7
93	180	5926	9307		397	642.9
94	180	6129	9311		397	663.9

Copy of 89 IND

	A	B	C	D	E	F
95	180	6631	9311		397	685.6
96	180	7152	9311		397	686.4
97	180	7241	9311		397	688.9
98	180	7466	9312		397	695.2
99	180	7844	9312		397	695.7
100	180	8685	9313		397	719.8
101	180	8701	9313		397	751
102	180	8839	9313		397	751.2
103	180	8861	9313		397	756.6
104	180	9483	9314		397	758.1
105	180	9607	9314		397	763.8
106	180	9823	9318		397	779.2
107	180	9905	9319		397	825.3
108	180	10581	9319		397	825.8
109	180	10783	9320		397	833.6
110	180	11774	9320		397	839.6
111	180	13782	9320		397	848.8
112	180	14740	9321		397	890.2
113	180	15032	9322		397	904
114	180	20820	9322		397	928
115	180	24018	9325		397	947
116	180	24219	9327		397	953.3
117	180	25188	9327		397	970.6
118	180	26797	9332		397	972.1
119	180	29582	9332		180	973.4
120	180	30178	9332		397	974.7
121	180	32147	9334		397	976.4
122	180	34521	9339		397	990
123	180	38308	9340		397	1007.3
124	180	55659	9341		397	1015.9
125	180	58517	9342		397	1019
126	180	84490	9342		397	1028
127		6841.8176	12326.5512		397	1054.1
128					397	1077.6
129	89 entries >1000		22 entries <500		397	1084.1
130	i.e. 71% >1000 hrs		i.e. 17% <500hrs		397	1089.3
131					397	1098.5
132	62 entries >2500				397	1117.9
133	i.e. 49% >2500				397	1126.1
134					397	1126.7
135	41 entries >5000				397	1134.8
136	i.e. 33% >5000				397	1175.2
137					397	1175.8
138					397	1176.4
139					397	1186
140					397	1229.9
141					397	1230

228

	A	B	C	D	E	F
142					397	1242.5
143					397	1244
144					397	1254
145					397	1270
146					397	1292.3
147					397	1296.3
148					397	1319.3
149					397	1326.1
150					397	1357.3
151					397	1372.8
152					397	1378.7
153					397	1424
154					397	1431.7
155					397	1449.1
156					397	1469.8
157					397	1493.7
158					397	1503.9
159					397	1518
160					397	1545.2
161					397	1561.8
162					397	1574.6
163					397	1623.9
164					397	1630.9
165					397	1649
166					397	1652.4
167					397	1656.7
168					397	1677
169					397	1717.9
170					397	1733
171					397	1733
172					397	1737.1
173					397	1740.9
174					397	1776.4
175					397	1777.8
176					397	1781
177					397	1830.9
178					397	1873.3
179					397	1964
180					397	1969.1
181					397	1997.5
182					397	1999
183					397	2069.4
184					397	2110.7
185					397	2147.8
186					397	2151
187					397	2162
188					397	2300

	A	B	C	D	E	F
189					397	2313
190					397	2321.9
191					397	2373
192					397	2384
193					397	2423.8
194					397	2427
195					397	2494
196					397	2570.5
197					397	2593
198					397	2615
199					397	2618
200					397	2666
201					397	2773
202					397	2811
203					397	2827
204					397	2909
205					397	3122.5
206					397	3204
207					397	3604
208					397	3815
209					397	4048.8
210					397	4138
211					397	4189
212					397	4338
213					397	4430
214					397	4485
215					397	4762
216					397	4798
217					397	4805
218					397	4957
219					397	4969
220					397	5165
221					397	5296
222					397	5299
223					397	5349
224					397	5364
225					397	5812
226					397	5869
227					397	6525
228					397	6728
229					397	6829
230					397	6879
231					397	6970
232					397	7160
233					397	7414
234					397	7441
235					397	7825

	A	B	C	D	E	F
236					397	7871
237					397	7900
238					397	7961
239					397	7964
240					397	8219
241					397	8730
242					397	8847
243					397	9256
244					397	9540
245					397	9939
246					397	10295
247					397	11296
248					397	12698
249					397	13931
250					397	15039
251					397	15489
252					397	16057
253					397	16767
254					397	17534
255					397	18475
256					397	19622
257					397	25412
258					397	25488
259					397	25829
260					397	27510
261					397	28004
262					397	100670
263						3224.83755
264						
265						
266					140 entries >1000	
267					i.e. 53% >1000hrs	
268						
269						
270						

	G	H
1	JULIAN DATE	
2	9003	
3	9003	
4	9003	
5	9003	
6	9009	
7	9009	
8	9010	
9	9013	
10	9013	
11	9013	
12	9018	
13	9019	
14	-9019	
15	9019	
16	9026	
17	9026	
18	9031	
19	9034	
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21	9040	
22	9040	
23	9041	
24	9045	
25	9047	
26	9052	
27	9053	
28	9058	
29	9058	
30	9058	
31	9068	
32	9069	
33	9069	
34	9069	
35	9072	
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37	9074	
38	9079	
39	9080	
40	9081	
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43	9082	
44	9082	
45	9083	
46	9083	
47	9086	

	G	H
48	9086	
49	9101	
50	9102	
51	9102	
52	9104	
53	9115	
54	9116	
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58	9123	
59	9124	
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86	9165	
87	9168	
88	9168	
89	9169	
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93	9169	
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95	9169	
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97	9169	
98	9169	
99	9170	
100	9174	
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138	9222	
139	9222	
140	9222	
141	9222	

	G	H
142	9223	
143	9223	
144	9223	
145	9223	
146	9224	
147	9224	
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149	9224	
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181	9270	
182	9270	
183	9270	
184	9270	
185	9271	
186	9272	
187	9278	
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189	9279	
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191	9285	
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196	9292	
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226	9319	
227	9319	
228	9320	
229	9320	
230	9320	
231	9321	
232	9321	
233	9321	
234	9321	
235	9322	

	G	H
236	9322	
237	9326	
238	9327	
239	9332	
240	9334	
241	9334	
242	9334	
243	9336	
244	9336	
245	9339	
246	9340	
247	9340	
248	9342	
249	9342	
250	9342	
251	9343	
252	9343	
253	9346	
254	9347	
255	9348	
256	9348	
257	9348	
258	9348	
259	9349	
260	9349	
261	9349	
262	9354	
263	7728.71129	
264		
265		
266	75 entries <500	
267	i.e. 29% <500 hrs	
268		
269	93 entries <650	
270	i.e. 35% <650 hrs	

	A	B	C	D	E	F
1	TYPE	TIME METER	JULIAN DATE		TYPE	TIME METER
2	180	5	3		397	4
3	180	6	8		397	5
4	180	10	10		397	5
5	180	36	10		397	14
6	180	36	11		397	26
7	180	41	11		397	36
8	180	49	12		397	37
9	180	58	12		397	62
10	180	84	19		397	87
11	180	96	24		397	123
12	180	115	24		397	124
13	180	123	30		397	150
14	180	192	30		397	152
15	180	197	30		397	171
16	180	197	30		397	201
17	180	205	31		397	220
18	180	211	31		397	221
19	180	311	33		397	229
20	180	330	33		397	241.7
21	180	335	38		397	249
22	180	336	39		397	250
23	180	375.8	46		397	261
24	180	379	46		397	279
25	180	380	46		397	283
26	180	404	46		397	301
27	180	426	60		397	308
28	180	505	61		397	317
29	180	566	66		397	353
30	180	596	67		397	391
31	180	644.7	67		397	394
32	180	657	67		397	405
33	180	666	69		397	425
34	180	679	69		397	431
35	180	679	72		397	434
36	180	689	74		397	455
37	180	695	74		397	457.1
38	180	716	74		397	459
39	180	734.9	75		397	480
40	180	742	75		397	492
41	180	783	76		397	498
42	180	798	80		397	504
43	180	806	80		397	554
44	180	833	81		397	574
45	180	960	81		397	576
46	180	977	86		397	584
47	180	1000	88		397	602.5

	A	B	C	D	E	F
48	180	1002	88		397	603
49	180	1028	88		397	607
50	180	1054	89		397	607.6
51	180	1072	89		397	624
52	180	1094	98		397	645
53	180	1100	105		397	650
54	180	1130	150		397	671
55	180	1139	150		397	704
56	180	1178	151		397	729
57	180	1210	151		397	738
58	180	1259	152		397	774
59	180	1279	152		397	783
60	180	1330	153		397	825
61	180	1347	153		397	825
62	180	1361	156		397	839.9
63	180	1370	156		397	859
64	180	1397	156		397	1012
65	180	1402	157		397	1121.8
66	180	1428	158		397	1146
67	180	1456	166		397	1193
68	180	1585	166		397	1209
69	180	1590	172		397	1222
70	180	1619	172		397	1251
71	180	1653	172		397	1259
72	180	1688	172		397	1270
73	180	1752	172		397	1280
74	180	2009	173		397	1322
75	180	2095	173		397	1324.1
76	180	2150	173		397	1354
77	180	2151	173		397	1359
78	180	2183	173		397	1359
79	180	2200	173		397	1423
80	180	2287	174		397	1479
81	180	2291	174		397	1625
82	180	2348	174		397	1780
83	180	2374	174		397	1873
84	180	2391	174		397	1984.8
85	180	2415	174		397	1989
86	180	2462	176		397	1989
87	180	2577	176		397	2093
88	180	2606.2	176		397	2102
89	180	2610	176		397	2147
90	180	2631	179		397	2226.7
91	180	2672	179		397	2265
92	180	2690	181		397	2297
93	180	2696	186		397	2351
94	180	2715	186		397	2361

	A	B	C	D	E	F
95	180	2725	187		397	2363
96	180	2748	187		397	2603
97	180	2786	188		397	2652
98	180	2934	190		397	2692
99	180	3048	190		397	2708
100	180	3060.3	193		397	2904.5
101	180	3502	194		397	3150
102	180	3683	195		397	3336
103	180	3692	198		397	3448
104	180	3723	198		397	3561
105	180	3850	202		397	3721
106	180	4010	202		397	4243
107	180	4021	204		397	4940
108	180	4072	204		397	5332
109	180	4208	206		397	5552
110	180	4218	206		397	6115
111	180	4220	206		397	6165
112	180	4313	209		397	6239
113	180	4487	210		397	7072
114	180	4813	210		397	7663
115	180	5011	211		397	7800
116	180	5994	211		397	7894
117	180	6292	212		397	8358
118	180	6377	212		397	8740
119	180	7634	213		397	8846
120	180	7715	213		397	9541
121	180	7883	219		397	9947
122	180	8135	220		397	10025
123	180	8210	220		397	10128
124	180	12622	226		397	11244
125	180	13640	228		397	11368
126	180	21798	228		397	12208
127	180	22582	229		397	13728
128	180	23746	229		397	16321
129	180	27478	230		397	16402
130	180	29787	230		397	29034
131	180	34583	233			2741.20853
132	180	35775	233			
133	180	36800	235		67 entries >1000	
134	180	40805	235		i.e. 52% >1000 hrs	
135	180	54978	235			
136	180	58623	238		34 entries >2500	
137		4854.21185	9936.12009		i.e. 26% >2500 hrs	
138						
139	90 entries >1000		27 entries <500		min = 4	
140	i.e. 66% >1000hrs		i.e. 20% <500		max = 29034	
141						

	A	B	C	D	E	F
142	50 entries >2500					
143	i.e. 37% >2500 hrs					
144						
145	min = 5					
146	max = 58623					

	G	H
1	JULIAN DATE	
2	2	
3	2	
4	2	
5	2	
6	3	
7	4	
8	4	
9	4	
10	4	
11	8	
12	8	
13	8	
14	8	
15	10	
16	25	
17	25	
18	25	
19	25	
20	26	
21	26	
22	26	
23	26	
24	31	
25	33	
26	37	
27	37	
28	38	
29	38	
30	39	
31	52	
32	52	
33	52	
34	59	
35	60	
36	61	
37	61	
38	65	
39	65	
40	66	
41	66	
42	66	
43	67	
44	67	
45	68	
46	68	
47	68	

	G	H
48	68	
49	73	
50	73	
51	74	
52	74	
53	74	
54	75	
55	75	
56	76	
57	79	
58	79	
59	80	
60	81	
61	86	
62	86	
63	81	
64	81	
65	81	
66	90	
67	90	
68	90	
69	93	
70	93	
71	93	
72	93	
73	95	
74	96	
75	96	
76	100	
77	100	
78	100	
79	105	
80	109	
81	110	
82	110	
83	111	
84	114	
85	115	
86	115	
87	116	
88	118	
89	118	
90	118	
91	121	
92	121	
93	122	
94	123	

	G	H
95	123	
96	130	
97	130	
98	131	
99	131	
100	131	
101	134	
102	134	
103	135	
104	135	
105	136	
106	221	
107	221	
108	222	
109	222	
110	222	
111	222	
112	222	
113	222	
114	222	
115	222	
116	223	
117	223	
118	223	
119	223	
120	223	
121	223	
122	224	
123	224	
124	224	
125	224	
126	224	
127	225	
128	225	
129	226	
130	226	
131	4213.01202	
132		
133	41 entries <500hrs	
134	i.e. 32% <500hrs	
135		
136	52 entries <650	
137	i.e. 40% <650 hrs	
138		
139		
140		
141		

	G	H
142		
143		
144		
145		
146		

May 90

REJECTS FOR FY90

REJECT REASON	GTC85-56	GTC85-70	GTC85-71	GTC85-72	GTC85116	GTCP85397	GTCP85180	GTCP85180LS
HI-VIBRATION	1	2		7		2		
CAV-PRESSURE				1		1		
INTERNAL FAIL	1							
INSTABILITY		3		5				
LOW FLOW	1			1				
LOW PRESSURE								
NOISEY				1		1		
OTHER						2		
TOTALS	3	5	0	15	0	6	0	0

ENG'S SOLD	63
REJECTED	30

TOTALS BY REJECT REASON

HI-VIB = 12
CAV/PRESS = 2
INT.FAIL = 1
INSTABIL. = 8
LOW FLOW = 2
LOW PRESS = 0
NOISEY = 3
OTHER = 2

June 90

REJECTS FOR FY90
JUNE

REJECT REASON	GTC85-56	GTC85-70	GTC85-71	GTC85-72	GTC85116	GTCP85397	GTCP85180	GTCP85180LS
HI-VIBRATION	1	2				1	4	3
CAV-PRESSURE				2				
INTERNAL FAIL								1
INSTABILITY	3	4	5	5				
LOW FLOW	1			1				
LOW PRESSURE	1							
NOISEY								
OTHER								
TOTALS	6	6	5	8	0	1	4	4

ENG'S SOLD 68
REJECTED 34

TOTALS BY REJECT REASON
HI-VIB = 11
CAV/PRESS = 2
INT.FAIL = 1
INSTABIL. = 17
LOW FLOW = 2
LOW PRESS = 1
NOISEY = 0
OTHER = 0

July 90

REJECTS FOR FY90
JULY

REJECT REASON	GTC85-56	GTC85-70	GTC85-71	GTC85-72	GTC85116	GTCP85397	GTCP85180	GTCP85180LS
HI-VIBRATION	1		1	5		7	4	
CAV-PRESSURE								1
INTERNAL FAIL								
INSTABILITY		2	3	10				
LOW FLOW	1			1				
LOW PRESSURE								
NOISY				3				
OTHER				1		1		
TOTALS	2	2	4	20	0	8	4	1

ENG'S SOLD	86
REJECTED	33

TOTALS BY REJECT REASON

HI-VIB = 19
CAV/PRESS = 1
INT.FAIL = 0
INSTABIL. = 15
LOW FLOW = 2
LOW PRESS = 0
NOISEY = 3
OTHER = 2

248

1st half of Aug 90

REJECTS FOR FY90
as of 15 AUG 1990

REJECT REASON	GTC85-56	GTC85-70	GTC85-71	GTC85-72	GTC85116	GTCP85397	GTCP85180	GTCP85180LS
HI-VIBRATION				1		5	2	
CAV-PRESSURE		1						
INTERNAL FAIL								
INSTABILITY		3	3					
LOW FLOW								
LOW PRESSURE								
NOISY				1				
OTHER						1		
TOTALS	0	4	3	2	0	6	2	0

ENG'S SOLD 26
REJECTED 18

TOTALS BY REJECT REASON

HI-VIB = 8
CAV/PRESS = 1
INT.FAIL = 0
INSTABIL. = 6
LOW FLOW = 0
LOW PRESS = 0
NOISEY = 2
OTHER = 1

GTE REJECT ITEM LOG

From:
R. Samora
MATP&B

LOG #	C/N	NOUN	P/N	S/N	DATE INITIATED	DATE SUSPENSE
90-0001	13095A	FAN ASSY, OIL COOLER	75973	A-61	6-21-90	
90-0002	13095A	FAN ASSY OIL COOLER	75973	398	6-21-90	
90-0003	13495A	GEAR ASSY MAIN DRIVE	693211	SA-070	6-21-90	
90-0004	13094A	HEAT, SHIELD	75157	N/A	6-21-90	
90-0005	13494A	NOZZLE, OIL JET BRANCHED	693155-100	603	6-21-90	
90-0006	13495A	NOZZLE OIL JET BRANCHED	693155-100	601	6-21-90	
90-0007	13094A	SHAFT ASSY FAN DRIVE	372822	128	6-21-90	
90-0008	13084A	SHAFT ASSY ACC. DRIVE	75285-4	2106	6-21-90	
90-0009	13094A	HOUSING, ACCY CASE	372896-16	8906	6-22-90	
90-0010	13094A	SHAFT ASSY FAN DRIVE	372822	1365	6-22-90	
90-0011	13081A	GEAR ASSY MAIN DRIVE	693211	SA 606	6-22-90	
90-0012	13007A	COMPRESSOR SHROUD ASSY	968019-3	0315-1	6-22-90	
90-0013	13117A	TORUS TURBINE	376654-50	SA-916	6-22-90	
90-0014	13095A	FAN INLET	977077-1	N/A	6-22-90	
90-0015	13495A	LINER ASSY COMB CHAMB	369339-1	104	6-25-90	
90-0016	13495A	LINER ASSY COMB. CHAMBER	369339-1	SA 303	6-25-90	
90-0017	13495A	LINER ASSY COMB CHAMBER	369339-1	A-61	6-25-90	
90-0018	13495A	LINER ASSY COMB. CHAMBER	369339-1	215-1	6-25-90	
90-0019	13095A	RETAINER BEARING	75969	N-F	6-25-90	
90-0020	13495A	PIPE ASSY	379193-50	SA 518	6-25-90	
90-0021	13081A	HOUSING FAN INLET	370118	108	6-26-90	
90-0022	13495A	GEARSHAFT BEVEL	693120	N/A	6-26-90	
90-0023	13495A	GEARSHAFT SPUR SPRL.COUP.	697607-1	SA-12	6-26-90	
90-0024	13495A	SHROUD COMPRESSOR	372555	F-51	6-26-90	
90-0025	13094A	SHROUD COMPRESSOR	372555	872	6-26-90	
90-0026	13095A	SHAFT ASSY ACCY DR	75285-4	N/A	6-26-90	
90-0027	13119A	HOUSING BEARING ASSY	696659-120	ML-147993	6-26-90	
90-0028	13095A	PIPE EXHAUST	899607-1	703	6-26-90	

LOG #	B/N	NOUN	P/N	S/N	DATE INITIATED	 SUSPENSE
90-0029	13495A	Gearshaft, Bevel	693120		6/26-90	
90-0030	13094A	Shroud, Comp.	372555	872	6/26-90	
90-0031	13095A	Housing 2nd stg diff	698195-6	68A5-12	6/27-90	
90-0032	13111A	Housing, Turb. Bearing	373237-250	5172	6/27-90	
90-0033	13095A	Housing 2ND STG DIFF.	698195-6	35A26-10	6/27-90	
90-0034	13081A	IMPELLER 2nd STAGE	372553-6	5560	6/27-90	
90-0035	3094A	Housing ASSY	373822-11	0217	6/27/90	
90-0036	3495A	Gear Shaft	693120	—	6/27/90	
90-0037	3494A	Gear ASSY Main drive	693211	0029A	6/28/90	
90-0038	3494A	Gear ASSY Main Dr.	693211	034	6/28/90	
90-0039	3111A	Gear ASSY Main Dr.	693211	—	6/28/90	
90-0040	13095A	Housing 2nd stage diff	698195-6	48A318	6/28/90	
90-0041	13095A	Housing 2nd stg diff	698195-6	57A12-9	6/28/90	
90-0042	13094A	SHAFT ASSY Fan drive	372822	SATPNC183	6/28/90	
90-0043	3094A	SHAFT ASSY FAN Drive	372822	—	6/28/90	
90-0044	13095A	Gear overspeed drive	72004	—	6/28/90	
90-0045	13495A	Gear ASSY Maindrive	693211	—	6/29/90	
90-0046	13081A	GEAR ASSY MAINdrive	373613-3	183	6/29/90	
90-0047	3495A	Gear Shaft, Spur	697607-1	4-300	6/29/90	
90-0048	13081A	SHAFT ASSY, Fan drive	373613-3	—	6/29/90	
90-0049	13045A	Housing 2nd STG. diff	698195-6	36A2-16	6/29/90	
90-0050	13095A	Housing 2nd stg. diff	698195-6	57A129	6/29/90	
90-0051	3497A	Housing 2nd stg. diff	698195-6	611A2612	6/29/90	
90-0052	13095A	Shroud Support	968984-1	SA8135	6/29/90	
90-0053	13111A	Gear ASSY, MAIN drive	693211	300	6/29/90	
90-0054	13095A	SHAFT ASSY FAN drive	372822-2	—	6/29/90	
90-0055	13095A	SHAFT ASSY, Fandrive	372822-2	39	6/29/90	
90-0056	13095A	SHAFT ASSY, Fan drive	372822-2	—	6/29/90	

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	LOG #	C/N	NOUN	P/N	S/N	DATE	
						INITIATED	SUSPE
	90-0057	3081A	Housing, Turbine bearing	373237-250	2627	6/30/90	
	90-0058	3094A	Housing, Turbine bearing	373237-250	27P2324	6/30/90	
	90-0059	3081A	Nozzle, Turbine	376117-5	329	6/30/90	
	90-0060	3495A	Nozzle, Turbine	376117-5	8306	6/30/90	
	90-0061	3095A	Housing 2nd stg. Comp.	698188-1	HT0922	6/30/90	
	90-0062	3081A	Gear ASSY, MAIN drive	693211	S.A.648	6/30/90	
	90-0063	3495A	Rotating ASSY, Turbine	696327-2	2894	6/30/90	
	90-0064	3495A	Gear ASSY MAIN Drive	693211	848	6/30/90	
	90-0065	3494A	Gear ASSY, MAIN Drive	693211	789	7/02/90	
	90-0066	3081A	Gear ASSY, MAIN Drive	693211	—	7/02/90	
	90-0067	3495A	Gear ASSY, MAIN Drive	693211	SA033	7/02/90	
	90-0068	3095A	Housing Bearing	696659-160	ML162278	7/02/90	
711	90-0069	3111A T9450A	IMPELLER 2nd stg.	372556	817	7/02/90	
712	90-0070	3111A "	" " "	372556	809	7/02/90	
3973	90-0071	3094A	" " "	372556	5005	7/02/90	
714	90-0072	3111A	" " "	372556 #328	655	7/02/90	
715	90-0073	3111A	" " "	372556 #329	240	7/02/90	
3971	90-0074	3094A	" " "	372556 #311	120	7/02/90	
56	90-0075	3494A	" " "	372556	9190K	7/02/90	
3972	90-0076	T9450	" " "	372556	SA88016	7/02/90	
9	90-0077	3094A	" " "	372556	209	7/02/90	
10	90-0078	T9450	" " "	372556	X23	7/02/90	
3971	90-0079	3094A	" " "	372556 513	1902	7/02/90	
12	90-0080	T9450	" " "	372556	H11	7/02/90	
13	90-0081	13094A	" " "	372556 214	3064	7/02/90	
14	90-0082	T9450A	" " "	372556	8996	7/02/90	
15	90-0083	13094A	IMPELLER 2nd STG.	372556	SA1261	7/03/90	252
16	90-0084	T9450A	" " "	372556	3648	7/03/90	

	LOG #	C/N	NOUN	P/N	S/N	DATE	
						INITIATED	SUSPEN
17	90-0085	T9450A	IMPELLER 2ND STG	372556	SA28	7/03/90	
18	90-0086	9450A	IMPELLER 2ND STG.	372556	5606	7/03/90	
19	90-0087	9450A	" " "	372556	7969	7/03/90	
20	90-0088	9450A	" " "	372556	X14	7/03/90	
21	90-0089	T9450A	" " "	372556	SA8577	7/03/90	
22	90-0090	T9450A	" " "	372556	88023	7/03/90	
23	90-0091	3111A	" " "	372556	4721	7/03/90	
24	90-0092	13495A	" " "	372556	7609	7/03/90	
25	90-0093	T9450A	" " "	372556	78910	7/03/90	
26	90-0094	3494A	" " "	372556	SA149	7/03/90	
27	9 00095	9450A	" " "	372556#186	SA050	7/03/90	
	90-0096	3495A	GEAR, FAN IDLER	693123	—	7/03/90	
	90-0097	3495A	Gear, Fan Idler	693123	—	7/03/90	
	90-0098	3095A	DIFFUSER; 1st STG. Grp	698194-1	TAC55581	7/03/90	
	90-0099	3094A	SHAFT ASSY, ACC Drive	75385-4	SA718C	7/03/90	
	90-0100	3095A	Housing, 2ND STG. diffuser	698195-6	56A7-9	7/03/90	
	90-0101	13095A	Housing 2ND STG. diffuser	698195-6	77A6	7/03/90	
	90-0102	3497A	" " " "	698195-6	SA22-10	7/03/90	
	90-0103	3111A	Torus, Turbine	376654-50	SA916	7/05/90	
	90-0104	3111A	Torus, Turbine	376654-50	SAM6567	7/05/90	
	90-0105	3094A	Torus, Turbine	376654-50	65089	7/05/90	
	90-0106		Torus, Turbine	376654-50	5615	7/05/90	
12	90-0107	13495	Plenum	370210	—	7/05/90	
	90-0108	13095A	FAN INLET	977077-1	—	7/05/90	
	90-0109	3494A	Gear Assy, Main Drive	693211	—	7/06/90	
	90-0110	3095A	Fan Assy, oil Cooler	75973	SA 84	7/12/90	
	90-0111	3094A	" " " "	75973	384816	7/12/90	253
	90-0112	3094A	" " " "	75973	SA 502	7/12/90	

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	LOG	C/N	NOUN	P/N	S/N	DATE INITIATED	SUS.
	90-0113	3095A	FAN ASSY, OIL Cooler	75973	SA81	7/12/90	
	90-0114	3495A	Gear ASSY, MAIN DRIVE	693211	M33 SA722	7/12/90	
	90-0115	3495A	Torus, Turbine	376654-56	SAM61492	7/12/90	
	90-0116	3094A	" "	379185-52	1744	7/12/90	
	90-0117	3094A	" "	379185-52	0029	7/12/90	
	90-0118	3094A	" "	379185-52	SAM6222	7/12/90	
	90-0119	3095A	Liner Combustion Chamber	899244-5	931	7/13/90	
	90-0120	3095A	" " "	899244-5	2016	7/13/90	
	90-0121	3095A	" " "	899244-3	929	7/13/90	
	90-0122	3094A	Pipe ASSY, Turbine Exh	379193	SA6-11	7/13/90	
	90-0123	3496A	Gearshaft	693120	—	7/13/90	
	90-0124	3495A	"	693120	—	7/13/90	
	90-0125	3094A	Gear, Spur Pump	692531	—	7/13/90	
	90-0126	3495A	Gearshaft	693120	—	7/13/90	
	90-0127	3495A	Gear ASSY, MAIN DR.	693211	SA183	7/17/90	
	90-0128	3111A	" " " "	693211	SA253	7/17/90	
	90-0129	3095A	Gear, OVERSPEED DR.	72004	—	7/17/90	
	90-0130	3495A	Rotating ASSY, Turbine	696327-2	2894	7/17/90	
	90-0131	3094A	GEAR ASSY. DR.	75331-4	—	7/18/90	
	90-0132	3095A	Torus ASSY	376654-50	SAM45345	7/13/90	
	90-0133	3111A	Gear ASSY MAIN Drive	693211	SAM174	7/23/90	
	90-0134	3497A	Housing 2nd Stage diffuser	698195-2	C5069151R	7/23/90	
420	90-0135	3094A	Housing, Turbine bearing	373237-250	30924	7/24/90	
	90-0136	3111A	" " "	373237-250	470	7/24/90	
	90-0137	3084A	" " "	373237-200	47P2854	7/24/90	
0	90-0138	3094A	Plenum ASSY Turbine	370083-2	SAM10820	7/24/90	
	90-0139	3094A	TORUS, Turbine	379185-52	33367	7/24/90	254
	90-0140	3495A	Plenum Assy, Turbine	370210	SAM191	7/24/90	

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LOG	S/N	NOUN	P/N	S/N	DATE INITIATED	SUSP
90-0141	3081A	GEAR ASSY MAIN DRIVE	693211	SA223	7/30/90	—
90-0142	3495A	GEARSHAFT Spur Stn [illegible]	697607-1	0114	7/30/90	—
90-0143	3494A	PLATG ASSY, Turbine [illegible]	7493-1	SA1621	7/31/90	—
90-0144	3094A	PLATG ASSY, oil Cooler	75973	SA69613	7/31/90	—
90-0145	3424A	Gear ASSY, MAIN DRIVE	693211-	SA773	7/31/90	—
90-0146	3111A	Rotating ASSY Turbine	696327-2	112	8/01/90	—
90-0147	3495A	LINER ASSY, Comb. Chamber	369339-1	701	8/01/90	—
90-0148	3095A	Housing, 2nd STG. diffuser	698195-6	95A29	8/06/90	—
90-0149	3095A	" " " "	698195-6	08A8	8/06/90	—
90-0150	3111A	Housing ASSY Accy Dr.	373623-3	1964	8/07/90	—
90-0151	3112A	Shroud Turb wheel	379848	5115	8/07/90	—
90-0152	13495A	GEAR Assy, MAIN DRIVE	6932 11	SA183	8/08/90	—
90-0153	13495A	Housing, Turbine bearing	373237-200	40P5162	8/08/90	—
90-0154	13094A	" " "	373237-250	P30843	8/08/90	—
90-0155	3094A	SHAFT ASSY, Fan drive	372822	SA108024	8/10/90	—
0156	3094A	Housing 2nd STG. diffuser	372647-100	0170	8/10/90	—
0157	3094A	" bearing Gen. Dr.	371728	⟶	8/10/90	—
0158	3095A	" 2nd Stg. Compressor	698198-1	HT1129	8/10/90	—
0159	3094A	LINER ASSY, Comb. Chamber	369339-1		8/13/90	—
0160	3095A	Nozzle, Turbine	326117-5	862	8/13/90	—
0161	3111A	Housing, turbine bearing	373237-250	30046	8/13/90	—
0162	3494A	" " "	373237-200	0794	8/13/90	—
0163	3111A	IMPELLER 2nd STG.	372556-327	SL5255	8/14/90	—
0164	13094A	Accy Case Hsg,	372896-16	SA3707	8/17/90	—
0165	13095A	"	372896-20	SA82-082-734	8/17/90	—
0166	13094A	"	372896-16	SA 3288	8/17/90	—
0167	13095A	"	372896-20	SA 8215	8/17/90	255
0168	T6457J	"	372896-16	SA9390	8/17/90	—

LOG #	C/N	NOUN	P/N	S/N	DMY DATE INITIATED	SUS
90-0169	13495A	HOUSING ASSY, 2nd STAGE	378384-53	D45V	11/09/90	14/09
90-0170	13095A	HOUSING ASSY CASE	372896-20	SA 3960	11/09/90	14/09
90-0171	13095A	" " "	"	SA 8876	11/09/90	14/09
-0172	13095A	" " "	"	SA822256-350	11/09/90	14/09
-0173	13094A	Plenum Assy, Turbine	371083-2	SAM 720	14/09/90	
-0174	13494A	Housing Assy 2nd stage	378384-53	1415	17/09/90	
-0175	13081A	Diffuser Housing 1st stage	372933-2	3879	17/09/90	
-0176	13495A	Housing, Turbine Bearing	373237-250	585	17/09/90	
-0177	13495A	Housing Assy, Accessory Drive	373623-7	6002	17/09/90	
-0178	13495A	Housing, Turbine Bearing	373237-200	T-350	17/09/90	
-0179	13094A	Nozzle, turbine	378513-4	SA 327	17/09/90	
-0180	13494A	Housing Assy, 2nd stage	378384-57	A-0137-344	17/09/90	
-0181	13095A	Housing Assy, 2nd stage	698198-1	HT0612	17/09/90	
-0182	13095A	"	698198-1	HT 0615	17/09/90	
-0183	13095A	"	"	HT0916	17/09/90	
-0184	13094A	SHAFT ASSY, COMPRESSOR	371690-10	3716	18/09/90	
-0185						
0186						
0187						
0188						
0189						
0190						
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0192						
0193						
0194						
0195						
0196						

GTE 257

From
R. Samora

REJECT ITEMS LOG

6/21/90 - 9/18/90 MATP&B

LOG #	C/N	NOUN	P/N	S/N	DATE INITIATED	DATE SUSPENSE
90-0001	13095A	FAN ASSY, OIL COOLER	75973	A-61	6-21-90	
90-0002	13095A	FAN ASSY OIL COOLER	75973	398	6-21-90	
90-0003	13495A	GEAR ASSY MAIN DRIVE	693211	SA-070	6-21-90	
90-0004	13094A	HEAT, SHIELD	75157	N/A	6-21-90	
90-0005	*13494A	NOZZLE, OIL JET BRANCHED	693155-100	603	6-21-90	
90-0006	13495A	NOZZLE OIL JET BRANCHED	693155-100	601	6-21-90	
90-0007	13094A	SHAFT ASSY FAN DRIVE	372822	128	6-21-90	
90-0008	13094A	SHAFT ASSY ACC. DRIVE	75285-4	2106	6-21-90	
90-0009	13094A	HOUSING, ACCY CASE	372896-16	8906	6-22-90	
90-0010	13094A	SHAFT ASSY FAN DRIVE	372822	~~[illegible]~~ 1365	6-22-90	
90-0011	13081A	GEAR ASSY MAIN DRIVE	693211	SA 606	6-22-90	
90-0012	13007A	COMPRESSOR SHROUD ASSY	968019-3	0315-1	6-22-90	
90-0013	13117A	TORUS TURBINE	376654-50	SA-916	6-22-90	
90-0014	13095A	FAN INLET	977077-1	N/A	6-22-90	
90-0015	13495A	LINER ASSY COMB CHAMB	369339-1	104	6-25-90	
90-0016	13495A	LINER ASSY COMB. CHAMBER	369339-1	SA 303	6-25-90	
90-0017	13495A	LINER ASSY COMB CHAMBER	369339-1	A-61	6-25-90	
90-0018	13495A	LINER ASSY COMB. CHAMBER	369339-1	215-1	6-25-90	
90-0019	13095A	RETAINER BEARING	75969	N-F	6-25-90	
90-0020	13495A	PIPE ASSY	379193-50	SA 518	6-25-90	
90-0021	13081A	HOUSING FAN INLET	370118	108	6-26-90	
90-0022	13495A	GEAR SHAFT BEVEL	693120	N/A	6-26-90	
90-0023	13495A	GEARSHAFT SPUR START COUP.	697607-1	SA-12	6-26-90	
90-0024	13495A	SHROUD COMPRESSOR	372555	F-51	6-26-90	
90-0025	13094A	SHROUD COMPRESSOR	372555	872	6-26-90	
90-0026	13095A	SHAFT ASSY ACCY DR	75285-4	N/A	6-26-90	
90-0027	13119A	HOUSING BEARING ASSY	[illegible]39-120	ML-147993	6-26-90	
90-0028	13095A	PIPE EXHAUST	899607-1	703	6-26-90	

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LOG #	C/N	NOUN	P/N	S/N	DATE	
					INITIATED	SUSPENSE
90-0029	13495A	Gearshaft, Bevel	693120		6/26-90	
90-0030	13094A	Shroud, Comp.	372555	872	6/26-90	
90-0031	13095A	Housing 2nd stgdiff	698195-6	68A5-12	6/27-90	
90-0032	13111A	Housing, Turb. Bearing	373237-250	5172	6/27-90	
90-0033	13095A	HOUSING 2ND STG DIFF.	698195-6	35A26-10	6/27-90	
90-0034	13081A	IMPELLER 2nd STAGE	372556	5560	6/27-90	
90-0035	13094A	HOUSING ASSY	373822-11	0217	6/27/90	
90-0036	13495A	GEAR SHAFT	693120	—	6/27/90	
90-0037	13494A	Gear ASSY Maindriv	693211	0029A	6/28/90	
90-0038	13494A	Gear ASSY MAINDR.	693211	034	6/28/90	
90-0039	13111A	Gear ASSY Main dr.	693211	—	6/28/90	
90-0040	13095A	Housing 2nd stage diff	698195-6	48A318	6/28/90	
90-0041	13095A	Housing 2nd stg diff	698195-6	57A12-9	6/28/90	
90-0042	13094A	SHAFT ASSY FAN drive	372822	SATPNC183	6/28/90	
90-0043	13094A	SHAFT ASSY FAN DRIVE	372822	—	6/28/90	
90-0044	13095A	Gear overspeed driv	72004	—	6/28/90	
90-0045	13495A	Gear ASSY Maindrive	693211	—	6/29/90	
90-0046	13081A	GEAR ASSY MAIN drive	373613-3	183	6/29/90	
90-0047	13495A	Gear SHAFT, Spur	697607-1	4-300	6/29/90	
90-0048	13081A	SHAFT ASSY, Fan drive	373613-3	—	6/29/90	
90-0049	13045A	HOUSING 2nd STG. DIFF	698195-6	36A2-16	6/29/90	
90-0050	13095A	Housing 2nd stg. diff	698195-6	57A129	6/29/90	
90-0051	13497A	Housing 2nd stg. diff	698195-6	611A2612	6/29/90	
90-0052	13095A	Shroud Support	968984-1	SA 8135	6/29/90	
90-0053	13111A	Gear ASSY, MAIN drive	693211	300	6/29/90	
90-0054	13095A	SHAFT ASSY, FAN DRIVE	372822-2	—	6/29/90	
90-0055	13095A	SHAFT ASSY, Fan drive	372822-2	39	6/29/90	
90-0056	13095A	SHAFT ASSY, Fan drive	372822-2	—	6/29/90	

	LOG #	C/N	NOUN	P/N	S/N	DATE INITIATED	DATE SUSPE
	90-0057	3081A	Housing, Turbine bearing	373237-250	2627	6/30/90	
	90-0058	3094A	Housing, Turbine bearing	373237-250	27P2324	6/30/90	
	90-0059	3081A	Nozzle, Turbine	376117-5	329	6/30/90	
	90-0060	3495A	Nozzle, Turbine	376117-5	8306	6/30/90	
	90-0061	3095A	Housing 2nd stg. Comp.	698198-1	HT0922	6/30/90	
	90-0062	3081A	Gear ASSY, MAIN drive	693211	S.A.648	6/30/90	
	90-0063	3495A	Rotating ASSY, Turbine	696327-2	2894	6/30/90	
	90-0064	3495A	Gear ASSY MAIN Drive	693211	848	6/30/90	
	90-0065	3494A	Gear ASSY, MAIN Drive	693211	789	7/02/90	
	90-0066	3081A	Gear ASSY, MAIN Drive	693211	—	7/02/90	
	90-0067	3495A	Gear ASSY, MAIN Drive	693211	SA033	7/02/90	
	90-0068	3095A	Housing Bearing	696659-160	ML162278	7/02/90	
711	90-0069	3111A T9450A	IMPELLER 2ND stg.	372556	817	7/02/90	
712	90-0070	3111A "	" " "	372556	809	7/02/90	
3973	90-0071	3094A	" " "	372556	5005	7/02/90	
714	90-0072	3111A	" " "	372556 # 328	655	7/02/90	
715	90-0073	3111A	" " "	372556 # 329	240	7/02/90	
397	90-0074	3094A	" " "	372556 # 311	120	7/02/90	
56	90-0075	3494A	" " "	372556	9190K	7/02/90	
397	90-0076	T9450	" " "	372556	SA88016	7/02/90	
9	90-0077	3094A	" " "	372556	209	7/02/90	
10	90-0078	T9450	" " "	372556	X23	7/02/90	
397 11	90-0079	3094A	" " "	372556 513	1902	7/02/90	
12	90-0080	T9450	" " "	372556	+11	7/02/90	
13	90-0081	13094A	" " "	372556 214	3064	7/02/90	
14	90-0082	T9450A	" " "	372556	8996	7/02/90	259
15	90-0083	13094A	IMPELLER 2ND STG.	372556	SA1261	7/03/90	
16	90-0084	T9450A	" " "	372556	3648	7/03/90	

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	LOG #	C/N	NOUN	P/N	S/N	DATE	
						INITIATED	SUSPEN
17	90-0085	T9450A	IMPELLER 2ND STG	372556	SA28	7/03/90	
18	90-0086	9450A	IMPELLER 2ND STG.	372556	5606	7/03/90	
19	90-0087	9450A	" " "	372556	7969	7/03/90	
20	90-0088	9450A	" " "	372556	X14	7/03/90	
21	90-0089	T9450A	" " "	372556	SA-8577	7/03/90	
22	90-0090	T9450A	" " "	372556	88023	7/03/90	
23	90-0091	3111A	" " "	372556	4721	7/03/90	
24	90-0092	13495A	" " "	372556	7609	7/03/90	
25	90-0093	T9450A	" " "	372556	78910	7/03/90	
26	90-0094	3494A	" " "	372556	SA149	7/03/90	
27	9 00095	9450A	" " "	372556#186	SA050	7/03/90	
	90-0096	3495A	GEAR, FAN IDLER	693123	—	7/03/90	
	90-0097	3495A	Gear, Fan Idler	693123	—	7/03/90	
	90-0098	3095A	DIFFUSER, 1st STG. Grp	698194-1	TAC5558	7/03/90	
	90-0099	3094A	SHAFT ASSY, ACC Drive	75285-4	SA718C	7/03/90	
	90-0100	3095A	Housing, 2ND STG. DIFFUSER	698195-6	56A7-9	7/03/90	
	90-0101	3095A	Housing 2ND STG. DIFFUSER	698195-6	77A6	7/03/90	
	90-0102	3497A	" " " "	698195-6	SA22-10	7/03/90	
	90-0103	3111A	TORUS, Turbine	376654-50	SA916	7/05/90	
	90-0104	3111A	Torus, Turbine	376654-50	SAM65671	7/05/90	
	90-0105	3094A	TORUS, Turbine	376654-50	65089	7/05/90	
	90-0106		TORUS, Turbine	376654-50	5615	7/05/90	
12	90-0107	3495	Plenum	370210	—	7/05/90	
	90-0108	13095A	FAN INLET	977077-1	—	7/05/90	
	90-0109	13494A	Gear Assy, Main Drive	693211	—	7/06/90	
	90-0110	3095A	Fan Assy, oil Cooler	75973	SA84	7/12/90	
	90-0111	3094A	" " " "	75973	384816	7/12/90	
	90-0112	3094A	" " " "	75973	SA502	7/12/90	

	LOG	C/N	NOUN	P/N	S/N	DATE	
						INITIATED	SUS
	90-0113	3095A	FAN ASSY, OIL Cooler	75973	SA81	7/12/90	
	90-0114	3495A	Gear ASSY, MAIN DRIVE	693211	M33 SA722	7/12/90	
	90-0115	3495A	Torus, Turbine	376654-56	SAM61492	7/12/90	
	90-0116	3094A	" "	379185-52	1744	7/12/90	
	90-0117	3094A	" "	379185-52	0029	7/12/90	
	90-0118	3094A	" "	379185-52	SAM62225	7/12/90	
	90-0119	3095A	Liner Combustion Chamber	899244-5	931	7/13/90	
	90-0120	3095A	" " "	899244-5	2016	7/13/90	
	90-0121	3095A	" " "	899244-3	929	7/13/90	
	90-0122	3094A	Pipe ASSY, Turbine Exh	379193	SA6-11	7/13/90	
	90-0123	3495A	Gearshaft	693120	—	7/13/90	
	90-0124	3495A	"	693120	—	7/13/90	
	90-0125	3094A	GEAR, SPUR Pump	692531	—	7/13/90	
	90-0126	3495A	Gearshaft	693120	—	7/13/90	
	90-0127	3495A	Gear ASSY, MAIN Dr.	693211	SA183	7/17/90	
	90-0128	3111A	" " " "	693211	SA253	7/17/90	
	90-0129	3095A	Gear, OVERSPEED Dr.	72004	—	7/17/90	
	90-0130	3495A	Rotating ASSY, Turbine	696327-2	2894	7/17/90	
	90-0131	3094A	GEAR ASSY. Dr.	75331-4	—	7/18/90	
	90-0132	3095A	TORUS ASSY	376654-50	SAM45345	7/13/90	
	90-0133	3111A	Gear ASSY MAIN Drive	693211	SAM174	7/23/90	
	90-0134	3497A	Housing 2nd Stage diffuser	698195-2	CS069159R	7/23/90	
420	90-0135	3094A	Housing, Turbine bearing	373237-250	30924	7/24/90	
	90-0136	3111A	" " "	373237-250	470	7/24/90	
	90-0137	3084A	" " "	373237-200	47P2854	7/24/90	
	90-0138	3094A	Plenum ASSY Turbine	370083-2	SAM10820	7/24/90	267
	90-0139	3094A	TORUS, Turbine	379185-52	33367	7/24/90	
	90-0140	3495A	Plenum Assy, Turbine	370210	SAM191	7/30/90	

LOG	C/N	NOUN	P/N	S/N	DATE INITIATED	DATE SUSP
90-0141	13081A	GEAR ASSY MAIN DRIVE	693211	SA223	7/30/90	
90-0142	13495A	GEARSHAFT Spur Startr Cy	697607-1	0114	7/30/90	
90-0143	13494A	FLANG ASSY, Turbine Exh	7493-1	SA1621	7/31/90	
90-0144	13094A	FLANG ASSY, oil Cooler	75973	SA69613	7/31/90	
90-0145	13494A	Gear ASSY, MAIN DRIVE	693211	SA773	7/31/90	
90-0146	13111A	Rotating ASSY Turbine	696327-2	112	8/01/90	
90-0147	13495A	LINER ASSY, Comb. Chamber	369339-1	701	8/01/90	
90-0148	13095A	Housing, 2nd STG. diffuser	698195-6	95A29	8/06/90	
90-0149	13095A	" " " "	698195-6	08A8	8/06/90	
90-0150	13111A	Housing ASSY Accy Dr.	373623-3	1964	8/07/90	
90-0151	13112A	Shroud Turb wheel	379848	5115	8/07/90	
90-0152	13495A	GEAR Assy, MAIN DRIVE	693211	SA183	8/08/90	
90-0153	13495A	Housing, Turbine bearing	373237-200	80P5162	8/08/90	
90-0154	13094A	" " "	373237-250	P30843	8/08/90	
90-0155	13094A	SHAFT ASSY, Fan Drive	372822	SA108026	8/10/90	
0156	13094A	Housing 2nd STG. diffuser	372647-100	0170	8/10/90	
0157	13094A	" bearing Gen. Dr.	371728	—	8/10/90	
0158	13095A	" 2nd stg. Compressor	698198-1	HT1129	8/10/90	
0159	13094A	LINER ASSY, Comb. Chamber	369339-1		8/13/90	
0160	13095A	Nozzle, Turbine	376117-5	862	8/13/90	
0161	13111A	Housing, turbine bearing	373237-250	30066	8/13/90	
0162	13494A	" " "	373237-200	0794	8/13/90	
0163	13111A	IMPELLER 2nd STG.	372556-327	SL5255	8/14/90	
0164	13094A	Accy Case Hsg	372896-16	SA3707	8/17/90	
0165	13095A	"	372896-20	SA82-012-734	8/17/90	
0166	13094A	"	372896-16	SA3288	8/17/90	
0167	13095A	"	372896-20	SA8215	8/17/90	
0168	15457J	"	372896-16	SA9390	8/17/90	

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LOG #	C/N	NOUN	P/N	S/N	DMY INITIATED	DATE SU
90-0169	13495A	HOUSING ASSY, 2nd STAGE	378384-53	D45V	11/09/90	14/09
90-0170	13095A	HOUSING ASSY CASE	372896-20	SA 3960	11/09/90	14/09
90-0171	13095A	" " "	"	SA 8876	11/09/90	14/09
-0172	13095A	" " "	"	SA822256-350	11/09/90	14/09
-0173	13094A	Plenum Assy, Turbine	371083-2	SAM 720	14/09/90	
-0174	13494A	Housing Assy 2nd stage	378384-53	1415	17/09/90	
-0175	13081A	Diffuser Housing 1st stage	372933-2	3879	17/09/90	
-0176	13495A	Housing, Turbine Bearing	373237-250	585	17/09/90	
-0177	13495A	Housing Assy, Accessory Drive	373623-7	6002	17/09/90	
-0178	13495A	Housing, Turbine Bearing	373237-200	T-350	17/09/90	
-0179	13094A	Nozzle, turbine	378513-4	SA 327	17/09/90	
-0180	13494A	Housing Assy, 2nd stage	378384-57	A-0137-344	17/09/90	
-0181	13095A	Housing Assy, 2nd stage	698198-1	HT0612	17/09/90	
-0182	13095A	"	698198-1	HT 0615	17/09/90	
-0183	13095A	"	"	HT0916	17/09/90	
-0184	13094A	SHAFT ASSY, COMPRESSOR	371690-10	3716	18/09/90	
-0185						
0186						
0187						
0188						
0189						
0190						
0191						
0192						
0193						
0194						263
0195						
0196						

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/85 THRU 09/30/86

HIGH VIBRATIONS

MODEL NUMBER	ACC-CASE	TURBINE	COMPRESSOR	TOTAL
-106	0	3	0	3
-165	0	0	0	0
-180	15	17	0	30
-180L	3	0	0	3
-36-50	0	0	0	0
-397	12	2	3	17
-56	0	1	1	2
-56.	0	0	0	0
-70	0	5	5	9
-71	0	4	2	6
-72	2	4	11	16
	32	36	22	86

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/86 THRU 09/30/87

HIGH VIBRATIONS

MODEL NUMBER	ACC-CASE	TURBINE	COMPRESSOR	TOTAL
-106	0	0	0	0
-165	0	0	0	0
-165-1	0	0	0	0
-180	0	3	0	3
-180L	0	1	0	1
-397	1	1	7	9
-56	0	0	0	0
-70	0	1	1	2
-71	0	0	1	1
-72	0	1	2	3
	1	7	11	19

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/87 THRU 09/30/88

HIGH VIBRATIONS

MODEL NUMBER	ACC-CASE	TURBINE	COMPRESSOR	TOTAL
-116	0	0	1	1
-165-1	4	1	0	4
-180	6	12	8	14
-180L	1	3	1	3
-397	6	2	10	16
-56	0	0	4	4
-70	0	0	7	7
-71	1	1	3	4
-72	1	0	6	7
T41M9	0	0	0	0
	19	19	40	60

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/88 THRU 09/30/89

HIGH VIBRATIONS

MODEL NUMBER	ACC-CASE	TURBINE	COMPRESSOR	TOTAL
-106	0	0	0	0
-116	0	0	0	0
-165	0	0	0	0
-165-1	0	0	0	0
-180	5	11	3	16
-180L	0	0	0	0
-36-50	0	0	0	0
-397	5	2	24	29
-56	0	2	2	4
-70	0	2	2	4
-71	1	1	2	3
-71 (T)	0	0	0	0
-71 MDR	0	0	0	0
-72	0	1	10	10
36-50	0	0	0	0
T41M9	0	0	0	0
	11	19	43	66

[illegible] ball bearing

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/85 THRU 09/30/86

HIGH CAVITY PRESSURE

MODEL NUMBER	ACC-CASE	TURBINE	TOTAL
-106	0	2	2
-165	1	1	2
-180	5	18	23
-180L	1	2	2
-36-50	0	0	0
-397	3	0	3
-56	0	2	2
-56.	0	0	0
-70	0	0	0
-71	0	2	2
-72	4	1	5
	14	28	41

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/86 THRU 09/30/87

HIGH CAVITY PRESSURE

MODEL NUMBER	ACC-CASE	TURBINE	TOTAL
-106	0	0	0
-165	0	0	0
-165-1	0	1	1
-180	1	5	6
-180L	0	1	1
-397	1	1	2
-56	0	0	0
-70	1	0	1
-71	0	0	0
-72	2	2	4
	5	10	15

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/87 THRU 09/30/88

HIGH CAVITY PRESSURE

MODEL NUMBER	ACC-CASE	TURBINE	TOTAL
-116	0	0	0
-165-1	2	0	2
-180	3	3	6
-180L	0	1	1
-397	1	0	1
-56	0	0	0
-70	1	1	2
-71	0	0	0
-72	2	0	2
T41M9	0	0	0
	9	5	14

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/88 THRU 09/30/89

HIGH CAVITY PRESSURE

MODEL NUMBER	ACC-CASE	TURBINE	TOTAL
-106	1	0	1
-116	0	0	0
-165	1	0	1
-165-1	0	0	0
-180	1	9	10
-180L	0	1	1
-36-50	0	0	0
-397	1	1	2
-56	0	0	0
-70	0	0	0
-71	0	0	0
-71 (T)	0	0	0
-71 MDR	0	0	0
-72	0	1	1
36-50	0	0	0
T41M9	0	0	0
	4	12	16

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/85 THRU 09/30/86

INTERNAL FAILURE

MODEL NUMBER	ACC-CASE	TURBINE	COMPRESSOR	TOTAL
-106	0	1	0	1
-165	1	0	0	1
-180	4	1	2	7
-180L	1	0	0	1
-36-50	0	1	0	1
-397	2	4	0	6
-56	0	1	1	2
-56.	0	0	0	0
-70	2	4	6	11
-71	0	3	2	5
-72	21	6	2	29
	31	21	13	64

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/86 THRU 09/30/87

INTERNAL FAILURE

MODEL NUMBER	ACC-CASE	TURBINE	COMPRESSOR	TOTAL
-106	0	0	0	0
-165	1	0	0	1
-165-1	0	0	0	0
-180	0	0	1	1
-180L	1	0	0	1
-397	1	0	0	1
-56	1	0	0	1
-70	1	0	0	1
-71	0	1	0	1
-72	4	1	0	5
	9	2	1	12

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/87 THRU 09/30/88

INTERNAL FAILURE

MODEL NUMBER	ACC-CASE	TURBINE	COMPRESSOR	TOTAL
-116	0	0	0	0
-165-1	0	1	0	1
-180	1	1	1	3
-180L	0	0	0	0
-397	4	4	0	8
-56	0	1	0	1
-70	0	1	0	1
-71	0	0	0	0
-72	1	4	1	6
T41M9	2	0	0	2
	8	12	2	22

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/88 THRU 09/30/89

INTERNAL FAILURE

MODEL NUMBER	ACC-CASE	TURBINE	COMPRESSOR	TOTAL
-106	0	0	0	0
-116	0	0	0	0
-165	0	0	0	0
-165-1	0	1	0	1
-180	1	0	1	2
-180L	0	0	0	0
-36-50	0	1	1	2
-397	4	2	4	9
-56	0	6	0	6
-70	1	0	1	2
-71	0	2	1	3
-71 (T)	0	2	0	2
-71 MDR	0	1	0	1
-72	2	6	2	10
36-50	1	0	0	1
T41M9	3	0	0	3
	12	21	10	42

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/85 THRU 09/30/86

REMOVALS

MODEL NUMBER	LOW PRESSURE	LOW FLOW	LOW SHAFT HORSE POWER	COMPLRESSOR INSTABLITY	TOTAL
-106	0	0	1	0	1
-165	0	0	0	0	0
-180	1	2	0	0	2
-180L	0	0	0	0	0
-36-50	0	0	0	0	0
-397	3	0	17	1	21
-56	2	0	0	4	6
-56.	0	0	0	1	1
-70	6	1	0	9	16
-71	4	6	0	4	13
-72	5	4	0	7	16
	21	13	18	26	76

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/86 THRU 09/30/87

REMOVALS

MODEL NUMBER	LOW PRESSURE	LOW FLOW	LOW SHAFT HORSE POWER	COMPRESSOR INSTABLITY	TOTAL
-106	0	0	0	0	0
-165	0	0	0	0	0
-165-1	0	0	0	0	0
-180	0	0	0	0	0
-180L	1	0	0	0	1
-397	0	1	12	1	13
-56	0	0	0	1	1
-70	0	0	0	15	15
-71	0	0	0	7	7
-72	0	1	0	16	17
	1	2	12	40	54

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/87 THRU 09/30/88

REMOVALS

MODEL NUMBER	LOW PRESSURE	LOW FLOW	LOW SHAFT HORSE POWER	COMPLRESSOR INSTABLITY	TOTAL
-116	0	0	0	0	0
-165-1	0	0	0	0	0
-180	0	0	1	0	1
-180L	0	0	0	0	0
-397	0	0	9	0	9
-56	0	5	0	17	19
-70	2	0	0	19	21
-71	1	2	0	30	32
-72	0	6	0	19	23
T41M9	0	0	0	0	0
	3	13	10	85	105

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/88 THRU 09/30/89

REMOVALS

MODEL NUMBER	LOW PRESSURE	LOW FLOW	LOW SHAFT HORSE POWER	COMPLRESSOR INSTABLITY	TOTAL
-106	0	0	0	0	0
-116	0	0	0	0	0
-165	0	0	0	0	0
-165-1	0	0	0	0	0
-180	0	0	0	0	0
-180L	0	0	0	0	0
-36-50	0	0	0	0	0
-397	0	0	6	0	6
-56	0	8	0	8	12
-70	0	0	0	7	7
-71	0	1	0	25	25
-71 (T)	0	0	0	5	5
-71 MDR	0	0	0	0	0
-72	0	0	0	9	9
36-50	0	0	0	0	0
T41M9	0	0	0	0	0
	0	9	6	54	64

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/85 THRU 09/30/86

FINDINGS

MODEL NUMBER	WORKMANSHIP	MATERIAL DEFICIENCY	TOTAL
-106	0	1	1
-165	0	0	0
-180	1	1	2
-180L	0	2	2
-36-50	0	0	0
-397	2	3	5
-56	0	0	0
-56.	0	0	0
-70	5	3	8
-71	5	1	6
-72	8	4	12
	21	15	36

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/86 THRU 09/30/87

FINDINGS

MODEL NUMBER	WORKMANSHIP	MATERIAL DEFICIENCY	TOTAL
-106	0	0	0
-165	0	0	0
-165-1	0	0	0
-180	1	0	1
-180L	0	0	0
-397	0	0	0
-56	0	0	0
-70	0	0	0
-71	0	0	0
-72	0	0	0
	1	0	1

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/87 THRU 09/30/88

FINDINGS

MODEL NUMBER	WORKMANSHIP	MATERIAL DEFICIENCY	TOTAL
=======	====	====	====
-116	0	0	0
-165-1	1	0	1
-180	1	0	1
-180L	0	0	0
-397	4	0	4
-56	1	0	1
-70	2	0	2
-71	1	0	1
-72	2	2	4
T41M9	1	0	1
	====	====	=====
	13	2	15

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/88 THRU 09/30/89

FINDINGS

MODEL NUMBER	WORKMANSHIP	MATERIAL DEFICIENCY	TOTAL
-106	4	0	4
-116	1	0	1
-165	1	0	1
-165-1	1	0	1
-180	6	1	7
-180L	0	1	1
-36-50	0	1	1
-397	15	4	19
-56	2	3	5
-70	5	0	5
-71	5	0	5
-71 (T)	1	0	1
-71 MDR	0	1	1
-72	4	7	11
36-50	1	0	1
T41M9	2	0	2
	48	18	66

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/85 THRU 09/30/86

TOTALS

MODEL NUMBER	NUMBER OF REJECTS
-106	6
-165	3
-180	61
-180L	6
-36-50	1
-397	51
-56	11
-56.	1
-70	40
-71	28
-72	74
	282

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/86 THRU 09/30/87

TOTALS

MODEL NUMBER	NUMBER OF REJECTS
-106	1
-165	1
-165-1	1
-180	11
-180L	3
-397	28
-56	2
-70	18
-71	9
-72	28
	102

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/87 THRU 09/30/88

TOTALS

MODEL NUMBER	NUMBER OF REJECTS
-116	1
-165-1	8
-180	25
-180L	4
-397	37
-56	23
-70	33
-71	35
-72	40
T41M9	3
	209

286

ENGINE REJECTS

MODEL NUMBER : ALL

FROM 10/01/88 THRU 09/30/89

TOTALS

MODEL NUMBER	NUMBER OF REJECTS
-106	5
-116	1
-165	1
-165-1	1
-180	28
-180L	1
-36-50	2
-397	48
-56	18
-70	13
-71	33
-71 (T)	7
-71 MDR	1
-72	28
36-50	1
T41M9	3
	191

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IMPROVEMENTS IN GTE PROCESS TO REDUCE VIBRATION REJECTIONS

1) 397 1st Stage Compressor
- guarantee that parts remain as matched sets
- mark parts so that relative positions are maintained
- balance each component individually prior to assembly
- is epoxy really needed (or superstitious time waster?)
- balance parts and CRA more precisely (spin at higher RPM in order to increase the sensitivity of the balancing equipment and also re-evaluate the current specs)
- scrap parts that appear to have large amounts of material removed

2) compressor shafts
- more precise inspection after machining (dimensional)
- re-evaluate tolerance specs
- balance more precisely (higher RPM on balancer)

3) balancing technique (in general)
- improve sensitivity by higher rotational speeds during balancing (on critical items)
- re-evaluate balance tolerance specs
- balance parts individually prior to assembly whenever possible

4) better and more frequent inspection of critical items prior to assembly

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RCC MATPGB SUBJECT SPC list

Following is a listing of some of the variables that may contribute to the vibration of the GTE's. A brief explanation of the variables follow, this page.

SOME POTENTIAL VARIABLES EFFECTING VIBRATION

A. Balancing Technique
  1) balancing speed (balancing machine sensitivity)
  2) balance quality grade (T.O. vs ISO.) of compoments
  3) prebalance of all compoments prior to assembly versus balancing only after subassembly (397 type compressor rotating assembly, CRA)

B. Machining Tolerences
  1) shaft regrind after metal spray
    a) 180 - concentricity of bearing surfaces and turbine wheel (co-incidence of mass centers and axis of rotation
    b) 397 - coincidence of splined portion of shaft and reground portions with the axis of rotation of the shaft
  2) fit of compressor impellers to shaft (example: interference fit of 397 second stage impeller to shaft varies causing a sloppy fit in some cases.)
  3) overall quality of machining tolerences maintained of all reworked compoments of the GTE'S (bearing housings, compressor housings, diffuser housings. Most important

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RCC MATPGB SUBJECT SPC

are those tolerences related to the location and attachment of bearings and rotating components (ie: alignment))

C. Assembly technique and proceedures

1) shaft runout after installation of 1st stage impeller (397 type)
2) stress relieving procedure after installation of 1st stage impeller (397 type)
3) use of cement to stabilize the position of 1st stage impeller (397 type)
4) bearing alignments during assembly

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RCC
SUBJECT GTE Rejections

Following is a summary of information gathered on the problems with GTE rejections.

Brent Castle has been working the rejection problem for about 2 years. Mr. Castle is a planner for the GTE's and has consolidated reject data for FYs 86, 87, 88 and 89 on a PC data base (DBASE I). Data was obtained from a reject log that is maintained in the GTE reassembly area. Data for FY 90 has not been entered into the PC data base and had to be obtained by inspection of the reject log.

The general consensus among those familiar with the GTE repair process appears to be that there is considerable room for improvement. Rough estimates of reject rates for FY 86-89 seem to confirm this. Engine delivery records obtained from Mr Zorita in scheduling were used to calulate reject rates. The reject rates are extremely variable from year to year, with change's of up to 100% possible. The 397 GTE has an overall reject rate of 27% over the 4 year period. and the 180 GTE has a reject rate of 16%. Rates were calculated by comparing total rejects to total deliveries.? This method of calculation tends to show a higher rate than other methods. For the 180 GTE vibration problems account for apx 50% of rejects and cavity pressure problems account for about 36% of rejects. For the 397 GTE vibrations cause about 43% of the rejects and removals account for another 30%. Vibrations

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are usually caused by inbalance in compressor sections of the engines but can also be caused by inbalance in the turbine or accessory case, bad bearings, or misalignments. Cavity pressure problems are usually caused by bad seals or clogged return lines in the oil sump systems. Removals are related to performance problems of the engine. For the 397 engine, about 90% of the removals are due to low shaft horsepower. Mr. Castle attributes most of the performance problems to air flow problems caused by case misalignments and/or turbine nozzle mismatch. He believes that the case alignments are difficult to prevent because they cannot be detected through external inspection. Nozzle mismatch is caused by a modification that has been made to the compressor section of the GTE in order to improve performance. The effective area of the turbine nozzle was not changed in this modification, thus causing a mismatch in some of the engines. According to Mr. Castle it is difficult to predict the mismatch without first running the engine on the test stand. Garrett is currently working on the turbine nozzle in order to determine the proper effective area that is required to match the compressor mods.

Of the problems causing rejects on the test stand, the vibration problem is the most troublesome and presents a good opportunity to increase production through quality improvement. Almost half of the rejects for the 180 and 397 engines are

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due to vibration problems. As mentioned earlier, excessive vibration can be caused by compressor rotating assembly (CRA) inbalance, turbine inbalance, bad bearings, case misalignments, or any combination of the above. Vibrations have been a major headache for a considerable period of time according to Glen W. Hunt, who is a supervisor in final assembly. Mr. Hunt says that a considerable amount of effort has been spent trying to solve vibration problems. However, problems still persist, especially with the CRA for the 397 engine. To date, no formal report has been published detailing the work and results of the effort to solve the vibration problems. Following is a more detailed discussion of the potential causes of the excessive vibration. The information was obtained from conversations with Mr. Castle and Mr. Hunt.

Compressor Rotating Assembly (CRA)

Most vibration problems are caused by inbalance in the CRA's. While CRA inbalance occurs in both the 180 and 397 GTEs, the 397 CRA causes the most problems. In fact, the problem with the 397 CRA is so severe that Mr. Hunt and Mr. Castle are convinced that there is a major design flaw in the CRA. Mr Hunt claims that Garrett engines has admitted to a design flaw with the first stage compressor in the 397 GTE. The theory is that the design of the first stage assembly allows a phenomenon called "stress migration" to occur at

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operating speeds of around 42,000 RPM. This "stress migration" causes a change in geometry and creates an in balance in the CRA that did not occur previously. Before discussing this subject further, first some general information regarding the CRA's for both engines. In both engines, the CRA consists of a shaft with the first and second stages of the compressor attatched. The first and second stage impellers for the 180 engine are of a one-piece design. For the 397 engine the second stage is a one piece design but the first stage is made up of an older 3 piece design. It
Assumed is this three piece first stage that causes
a vast majority of the problems with inbalance.

After disassembly and cleaning the shafts for the GTES are inspected. If the shaft is damaged or out of specs it is sent for plating and grinding of those areas that require it. Because these shafts rotate at very high speeds, it is critical that the centerlines of all the surfaces remain along the axis of rotation. This is particularly critical if not all of the surfaces are to be reworked. If set up is not done
Quality Assur. problem correctly, it is possible that some portions of the shaft will no longer be consentric with the axis of rotation. This would be the same (in effect) as creating a crankshaft and would make it very difficult to bring the CRA into balance with out removing an excessively large amount of material from the compressor wheels. Despite the critical nature of the machining, the CRA shafts are.

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not dimensionally checked after they leave the machine shop, according to Mr. Castle. In the past "bad batches" of shafts have caused vibration problems in completed engines. After machining, the shafts are rebalanced at 1800 RPM. During the balancing process material is removed from locations on the shaft that are specified on the TO until the shaft unbalance is within specs.

OPINION - The fact that "bad batches" of shafts are allowed to be assembled into completed engines is disturbing. Tighter dimensional inspection of shafts (prior to rebalancing) would help weed out the unsymetrical shafts. In theory, it is possible to rebalance a shaft that has been machined into an unbalanced shape (unsymetrical) but this might cause considerable problems when the compressor wheels are attached and the CRA is rotated at high speeds. Some of the shafts appeared to have a large amount of material removed from them in order to get them within balance specs. This would seem to indicate that perhaps the shafts were machined into an unsymetric shape and large amounts of material had to be removed in order to rebalance the shaft. I would think that a shaft that was truly symetrical (ideal) would be balanced already. In summary, because the shaft is the very foundation of the CRA special attention should be paid to machining

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total/ Dimensional/ insp. after machining → tolerances, inspection and balancing.
→ If necessary, machining and balancing tolerances should be tightened up.

After the shafts have been balanced, they are ready for reassembly with the compressor wheels. The compressor wheels are reworked in the following way. After disassembly and cleaning they are inspected. Any nicks and burrs are removed by grinding and polishing. Second stage wheels are rebalanced individually prior to reassembly onto the shaft. It is not possible to balance the entire CRA with the second stage attached because disassembly would be required prior to installation in the engine. Because the 2nd stage is attached with a press fit, removing it might cause damage to the shaft that would require remachining and rebalancing.

Because the 397 CRA is the most troublesome, the following applys to it specifically. The first stage compressor for the 397 is made up of a sandwich of 3 parts: one wheel and two inducers. All three components are made of titanium. The center portion of the sandwich, the wheel, is fairly massive and contains vanes extending out radially from the center. The outer portions of the sandwich, the inducers, are less massive and contain vanes in their centers. In operation, the inducers draw air in axially from each side of the compressor and the wheel compresses the air and ejects it radially. The air is then channeled through ducts to

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RCC ____ SUBJECT ____

to the second stage of the compressor. The three components of the 1st stage are designed to be a matched set. An attempt is made to keep the 3 pieces together. After the engine is disassembled the matched set is held together with a long bolt and wing nut. It is then sent to cleaning and inspection. After inspection of each component, the matched set is then sent for rework if it is required. At this stage, the inducer vanes are ground and polished to remove nicks and burrs caused by ingested particles. This rework is likely to create a slight inbalance in the inducers that has to be corrected in later balancing. The wheel portion of the 1st stage seldom needs rework at this stage. After any required work is done the three components are then sent to final assambly. Although the compressor arrives at the final assambly area as a set, there is no guarantee that somewhere in the rework process they were mixed with other compressor components. In addition to this, there is a potential problem related to the relative orientation of the components with each other. Because the parts where originally balanced as a set, changing the relative angular position of the parts might make rebalancing more difficult by requiring the removal of excess amounts of material. At present there is no procedure to keep the orientation of the parts the same as they were prior to disassembly. Also there is no procedure or marking system that would

[redacted]

why not use S/N o keep et integrity

why not alance these immediately

Alignment marks?

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RCC ______ SUBJECT ______

assure that the three components of the 1st stage compressor set remain matched. Prior to final assembly no attempt is made to balance the components of the 1st stage compressor individually (the second stage is balanced individually prior to assembly).

why not?

Final assembly proceeds as follows: Inducers are matched up the the wheel by identifying the orientation that best minimizes the mismatch between vanes. This step is highly subjective and based upon the craftman's best judgement of the alignment. It is possible that the final orientation of the parts will be different than that prior to disassembly because of the subjectivity in chosing the orientation the minimizes the average mismatch between vanes. Once the inducers are matched to the wheel, the group is placed in a clamp that precompresses them and they are slid onto the splines of the compressor shaft. Epoxy is poured into the gaps between the splines. A nut is placed on the shaft and tightened to a specified torque. The clamp is removed and the CRA assembly is baked for a period of time in order to speed the curing of the epoxy. Apparently, the epoxy is used to prevent the movement of the components on the shaft when the CRA is rotated at GTE operating speeds. It is believed that the movement of the components on the shaft is sufficient to create an imbalance and rejection of the engine in final test. Possible movement of the components on the splines doesnt appear to be more than 1 or 2 degrees at the

Any possible way to standardize this step?

how much force is pplied, nd what is this oing to he balance

Just, loes it ound ght. erstitions

ENGINEERING NOTES

EMPLOYEE Premo DATE ______ PAGE NO. 9

RCC ______ SUBJECT ______

most. After the shaft is removed from the oven and cooled, it is ready for balancing.

Balancing of the CRA is done on a Hofmann spin balancer. The machine is basically automatic in operation and is preprogramed. The mechanic places the CRA on teflon taped bearings on the balancer. The CRA is held in place by the drive belt which pulls down with a constant preload. The CRA is rotated at 1,800 RPM and inbalance results are automatically displayed on a CRT display. Inbalance at each bearing is given at a resolution of .0001 ounce, and the angular position of the inbalance for each bearing is displayed to the nearest degree. Angular positions are given relative to a piece of reflective tape that is placed on the CRA shaft prior to balancing. The TO's covering the balancing process specify the maximum allowable magnitude of inbalance for each end of the shaft. For the 397 CRA the tolerances are .002 ounce for one end and .006 for the other. However, the craftsmen are consistantly able to reduce the inbalance to 1/3 of the maximum allowed. In fact, they are able to balance the CRA to the point where the balancing machine is unable to consistantly specify the angular position of the inbalance. In order to balance the CRA material is removed from outer edges of the wheel and inducer. Rough balancing is done by grinding areas of the more massive wheel. Balance is fine tuned by grinding the outer edges of the inducers. The TO governing the balancing process specified where and how

Totally
nadequate
or operating
peeds
f 43,000
RPM

This is
he old
easure
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micrometer
...
syndrome

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ENGINEERING NOTES

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RCC ________ SUBJECT ________

much material can be removed from the wheel and inducers. If the part cannot be brought into balance by grinding to the specified limits the part is scrapped. Many parts appear to have had a large amount of material removed from their outer edges. The amount removed from the inducers seems excessively large considering the much smaller amount of material that is removed by grinding the damage to the vanes.

There has
to be a
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subjective
of doing
...s

Despite the extreme care taken by the craftman when balancing the CRA's it is not rare for a CRA to reject 2 or 3 times due to high vibration on the test stand. Mr. Hunt believes that something is physically changing during the process of running the engine on the test stand and causing an imbalance. This is the phenomenon he described as "stress migration", and is caused by an inherent design flaw in the 1st stage (three piece design instead of a more modern one piece cast design). There appears to be a consensus among some that there is no "cure" for the problem and that they must accept it (keep rebalancing the CRA's until it finally passes on the test stand).

Then
key are
placed
are they?!

Sounds
hokey
to me

In addition to vibration problems that are caused by the CRA, misalignments and bad bearings also cause some rejections. Misalignments can be caused machining tolerance buildups or improper assembly. A good example of this is the short stack for the 397. Because the short stack serves as the "foundation" of the GTE, any machining

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ENGINEERING NOTES

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RCC SUBJECT

flaws might cause misalignment of rotating assemblys, bearing binding problems and vibration. According to Mr. Castle, there is no rigorous inspection of the short stack prior to reassembly.

OPINION

Whether or not there is a design flaw in the current 397 compressor isn't important. The fact that they are failing so often is important. There is something in the process that is causing the high failure rate, and the problem just shows up most obviously in the 397 vibration rejects. Because the problem is so large it is difficult to pinpoint just one or two areas of improvement. Following is a list of potential causes and solutions to the vibration problem for the 397 CRA.

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RCC ________ SUBJECT ________

IMPROVEMENTS IN GTE PROCESS TO REDUCE VIBRATION REJECTIONS

1) 397 1st Stage Compressor
   - guarantee that parts remain as matched sets
   - mark parts so that relative positions are maintained
   - balance each component individually prior to assembly
   - is epoxy really needed (or superstitious time waster?)
   - balance parts and CRA more precisely (spin at higher RPM in order to increase the sensitivity of the balancing equipment and also re-evaluate the current specs)
   - scrap parts that appear to have large amounts of material removed

2) compressor shafts
   - more precise inspection after machining (dimensional)
   - re-evaluate tolerance specs
   - balance more precisely (higher RPM on balancer)

3) balancing technique (in general)
   - improve sensitivity by higher rotational speeds during balancing (on critical items)
   - re-evaluate balance tolerance specs
   - balance parts individually prior to assembly whenever possible

4) better and more frequent inspection of critical items prior to assembly

I would further suggest that all rework of these items be brought in-house (new machine shop) whereever possible. would suggest that items going to necessory backshops (plating) be inspected immediately upon return for quality of work.

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE [illegible] PAGE NO. 13

RCC [illegible] SUBJECT [illegible]

EXP #	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	1800 RPM	WITH CEMENT	1	NO PRE-BALANCE	1	1	RELIEVED
2	1800 RPM	WITH CEMENT	1	WITH PRE-BALANCE	2	2	RELIEVED
3	1800 RPM	NO CEMENT	2	NO PRE-BALANCE	1	2	RELIEVED
4	1800 RPM	NO CEMENT	2	WITH PRE-BALANCE	2	1	UN-RELIEVED
5	3000 RPM	WITH CEMENT	2	NO PRE-BALANCE	2	1	RELIEVED
6	3000 RPM	WITH CEMENT	2	WITH PRE-BALANCE	1	2	UN-RELIEVED
7	[illegible]	[illegible]	[illegible]	NO PRE-BALANCE	2	2	UN-RELIEVED
8	3000 RPM	NO CEMENT	1	WITH PRE-BALANCE	1	1	RELIEVED

CONTROL FACTORS
INNER ARRAY
1?0 and 3?7 Turbines

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10 620

REJECT SUMMARY

	SUMMARY OF REJECT DATA -			180 GTE	(TOTALS)	
FISCAL	VIBRATION	CAVITY	INTERNAL	REMOVALS	TOTAL	TOTAL
YEAR		PRESSURE	FAILURE		REJECTS	DELIVERIES
1987	3	6	1	1	11	94
1988	14	6	3	1	25	279
1989	16	10	2	0	28	104

	SUMMARY OF REJECT DATA -			180 GTE	(% OF DELIVERIES)	
FISCAL	VIBRATION	CAVITY	INTERNAL	REMOVALS	TOTAL	TOTAL
YEAR		PRESSURE	FAILURE		REJECTS	DELIVERIES
1987	0.03	0.06	0.01	0.01	0.12	94
1988	0.05	0.02	0.01	0.00	0.09	279
1989	0.15	0.10	0.02	0.00	0.27	104

	SUMMARY OF REJECT DATA -			397 GTE	(TOTALS)	
FISCAL	VIBRATION	CAVITY	INTERNAL	REMOVALS	TOTAL	TOTAL
YEAR		PRESSURE	FAILURE		REJECTS	DELIVERIES
1987	9	2	1	13	28	83
1988	16	1	8	9	37	185
1989	29	2	9	6	48	201

	SUMMARY OF REJECT DATA -			397 GTE	(% OF DELIVERIES)	
FISCAL	VIBRATION	CAVITY	INTERNAL	REMOVALS	TOTAL	TOTAL
YEAR		PRESSURE	FAILURE		REJECTS	DELIVERIES
1987	0.11	0.02	0.01	0.16	0.34	83
1988	0.09	0.01	0.04	0.05	0.20	185
1989	0.14	0.01	0.04	0.03	0.24	201

	1987	1988	1989
VIBRATION	0.03	0.05	0.15
TOTAL REJECT	0.12	0.09	0.27

	1987	1988	1989
VIBRATION	0.11	0.09	0.14
TOTAL REJECT	0.34	0.2	0.24

Raw Data For
Charts # 1 & 2

N

305

% 397 REJECTIONS

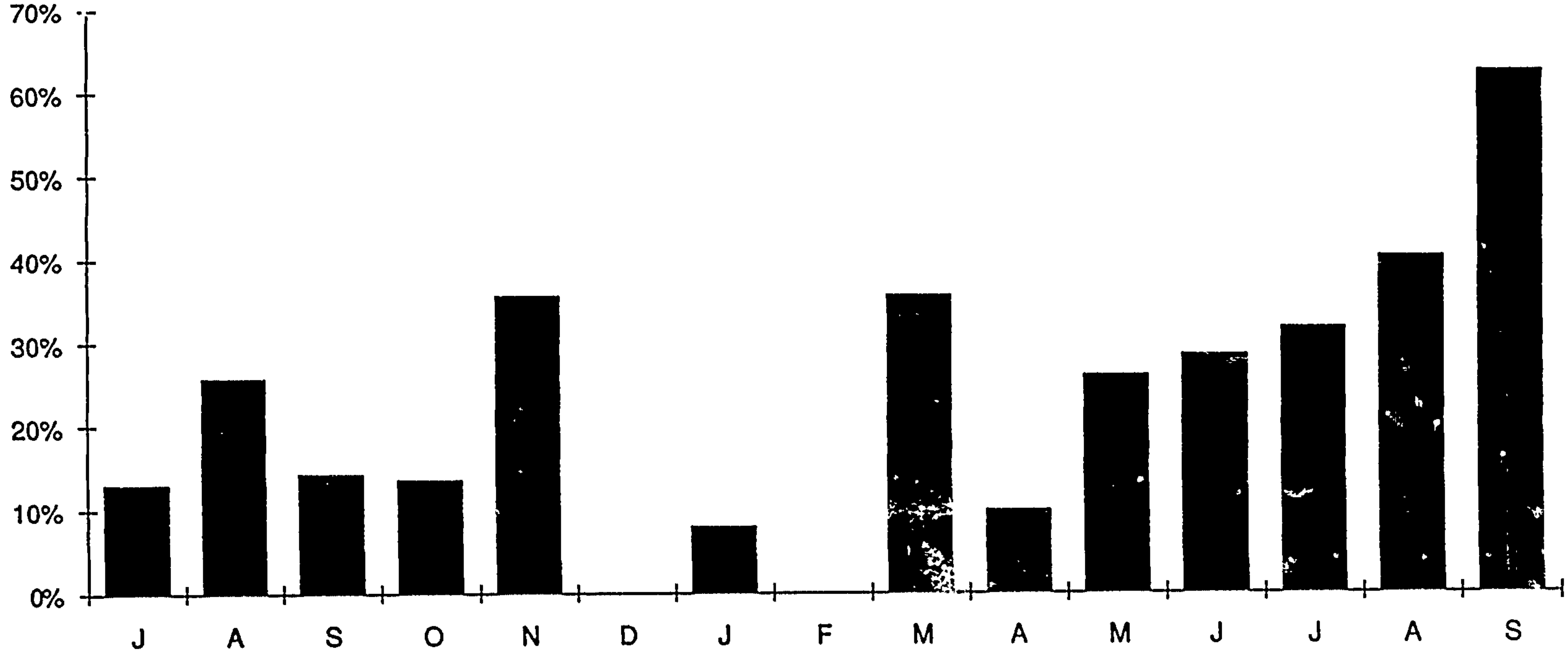

Chart #3

129

12

180 % REJECT CHART

%180 REJECTION

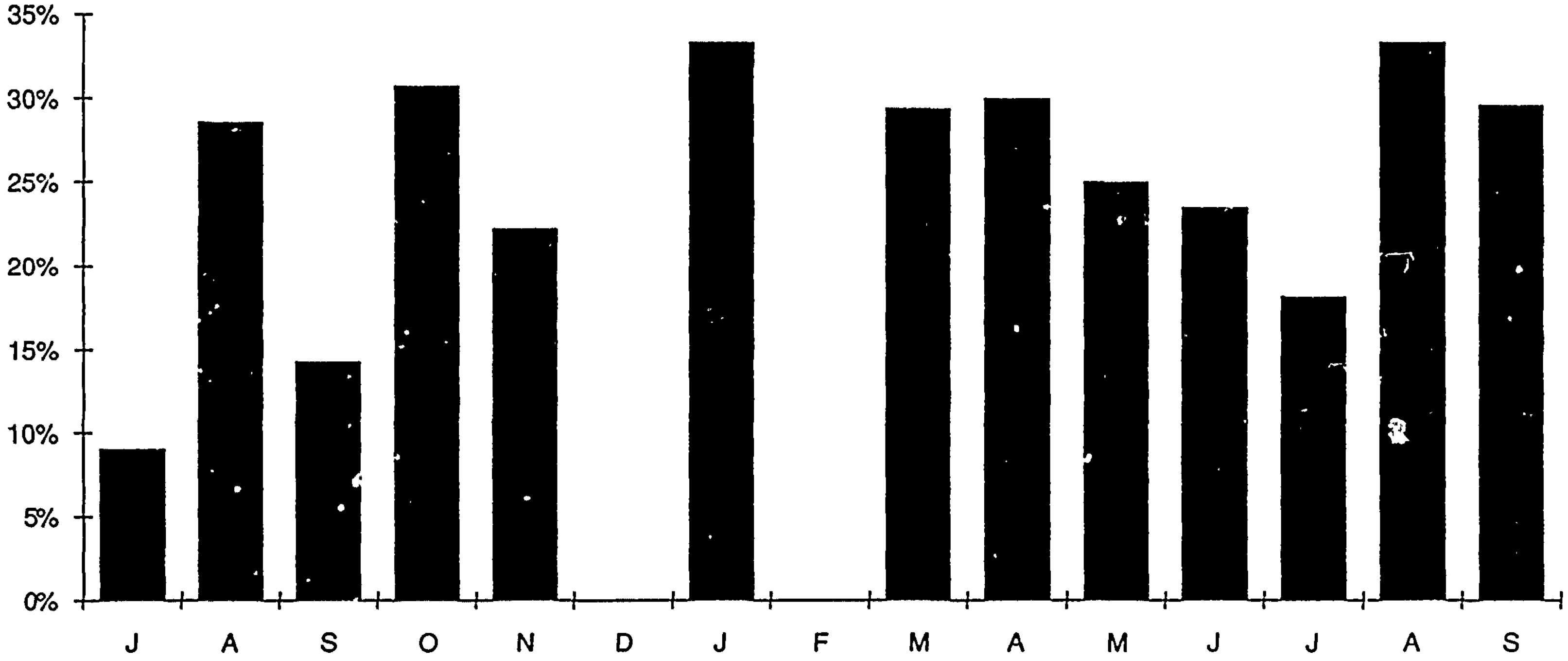

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Chart #4

622

611

ENGINEERING NOTES

EMPLOYEE GARDNER DATE 19 Nov 90 PAGE NO. 1

RCC MATPGB SUBJECT Vibration Rejects

Currently, vibration problems make up an average [illegible] % of the the total average 24 % rejection rate for the 397 and 180 GTEs. Of these vibration rejects, 76% are from excessive vibration in the turbine and compressor assemblies (Rotating Parts). MDMSC concludes from this that out-of-balance rotating parts are the single largest source of rejects/rework in the GTE repair process.

While Air Force engineers have studied this problem for several years, no systematic data appears to have been collected, and the problem appears to have continued (or even gotten worse) over the last 4 years. Charts #1&2 show rejection data for these engines since 1986 (the extent of the reject log book data available in MAT PGB). During MDMSC's investigation of this situation, SA-ALC engineers reported that they felt they had solved the problem. They ~~had~~ concluded that, by striking the assembled rotating assembly with a rubber mallet, prior to ~~a~~ spin-balancing, the cement used to secure the rotating parts is relaxed. The old process, (without the use of the mallet) balanced the assemblies with the cement (a loctite substitute) in a stressed state. Subsequent handling during final GTE assembly caused the cement to relax and the assembled units to become unbalanced. The proof of this success was cited as the drop in reject rates from 35% in September 1990, to 8% in October 1990.

MDMSC does ~~not~~ ~~dis~~agree that this process change <u>may</u> be a source of improvement in the spin-balance process. MDMSC does not, however, agree that the problem has been "solved". An examination of reject rates over the

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE 19 [illegible] 90 PAGE NO. [illegible]

RCC [illegible] SUBJECT [illegible]

[illegible] rejection rates [illegible] that this is an [illegible] complex problem, with many [illegible] of variation. MDMSC doubts that any one [illegible] to cause the problem.

As [illegible] in the preceding notes, MDMSC ~~[illegible]~~ questions the current spin-balancing process. The spin-balancing machines [illegible] two-plane balancing at 1200 RPM. At that [illegible], they are not sensitive enough to detect [illegible] in the armatures. While MDMSC engineers [illegible] that the machine's manufacturer claims that [illegible] ~~[illegible]~~ effectively at virtually any rotational speed, no data supporting this claim has been provided, pending approval from the manufacturers.

MDMSC ~~[illegible]~~ concludes that, given the apparent complexity of the situation and the lack of statistical process data, neither MDMSC nor SA-ALC engineers have any real idea about what's causing this problem. The only way to learn what is causing the [illegible] of [illegible] vibration is to conduct a series of scientific [illegible] and document the results. MDMSC engineers [illegible] experiments at the beginning of [illegible] [illegible] the [illegible] production [illegible] not support the disruption. MDMSC still feels that these experiments are critical and recommends that SA-ALC engineers conduct the Taguchi-based experimental procedure ~~recommended~~ described here.

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ENGINEERING NOTES

EMPLOYEE [illegible]
DATE 14 Nov 90
PAGE NO. 3
RCC [illegible]
SUBJECT vibration rejects

[illegible] were [illegible] in [illegible] D [illegible] recommended list of control factors. These factors were selected because MDMSC Engineers feel that they are [illegible] significant contributors to the balancing process and [illegible] they are under the control of MATREB balancing [illegible] [illegible]. The factors are described as follows

Spin Speed - As mentioned previously, MDMSC engineers believe a higher spin speed would more reliably identify [illegible] conditions which could contribute to vibration [illegible] [illegible]. If a larger pulley were used on the current balancing machines (and a shield set up to protect the balancing craftsmen in the event of a failure), a 3000 RPM spin speed could be obtained, with a corresponding [illegible]% increase in sensitivity.

CEMENT - The rotating assemblies are currently bonded together with an anaerobic cement similar to LOCTITE ~~[illegible]~~ (a less expensive substitute is actually used, under government specification). The purpose of this cement is to provide greater structural [illegible]. The [illegible] contribution to the repair of GTEs is [illegible] [illegible] [illegible] never been documented.

Pre-Balance - Currently, the individual rotating parts are not balanced prior to assembly into a rotating assembly. As they are randomly selected from the repair process, and have been "matched" with countless other parts during numerous trips through the depot, their balance is questionable. MDMSC engineers believe that, if these parts were balanced independently, the assemblies they become would be easier to balance and produce lower vibration levels.

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE [illegible] PAGE NO. 4

RCC [illegible] SUBJECT [illegible]

[illegible] may be important in achieving robotic balancing.

[illegible] To further evaluate the effects of these [illegible] recommends modeling their interactions with the change in spin speed. This will allow SA-ALC engineers to determine ~~[illegible]~~ the effects of process changes at different [illegible] of sensitivity of measurement (spin speed).

In addition to the control factors ~~[illegible]~~ contained in the array, [illegible] has identified a variety of noise factors which, though outside MATPSB's control, may have a significant effect on the vibration of an assembled engine. These factors are primarily dimensional characteristics of the subassemblies and are listed on the following pages.

The L_8 array should be repeated 4-6 times, with the quality characteristic the total vibration (measured in Mils) experienced at final test. The Taguchi main-effects analysis and analysis of variance will describe the contribution of each factor (including interactions) to the [illegible] of the vibration at final test.

By graphing the quality characteristic at each run against the values of the various noise factors, a picture of the sensitivity of the GTE vibration characteristic to various noise factors can be developed. It will be easy to see which are important and which trivial. By performing a S/N ratio evaluation SA-ALC engineers will be able to evaluate the [illegible] of changes in controls on sensitivity to noise.

DDB SECTION CODE DDB PAGE NO.

180 REJECTS (VIB)

180 REJECTS (% OF DELIVERIES)

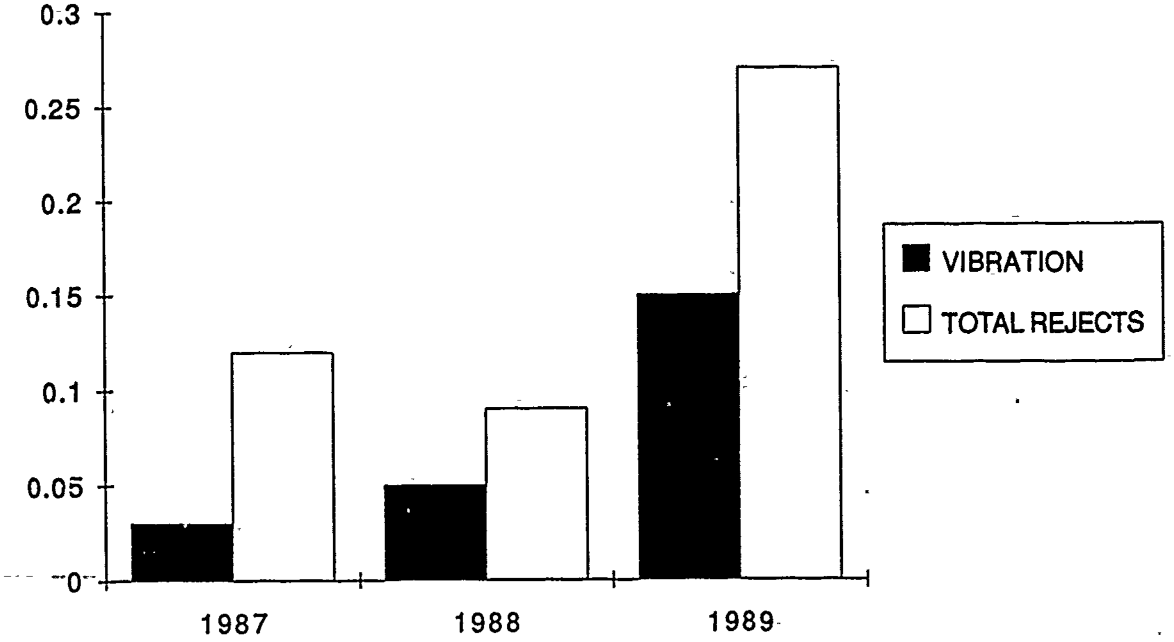

Chart #2

618
8

397 REJECTS (VIB)

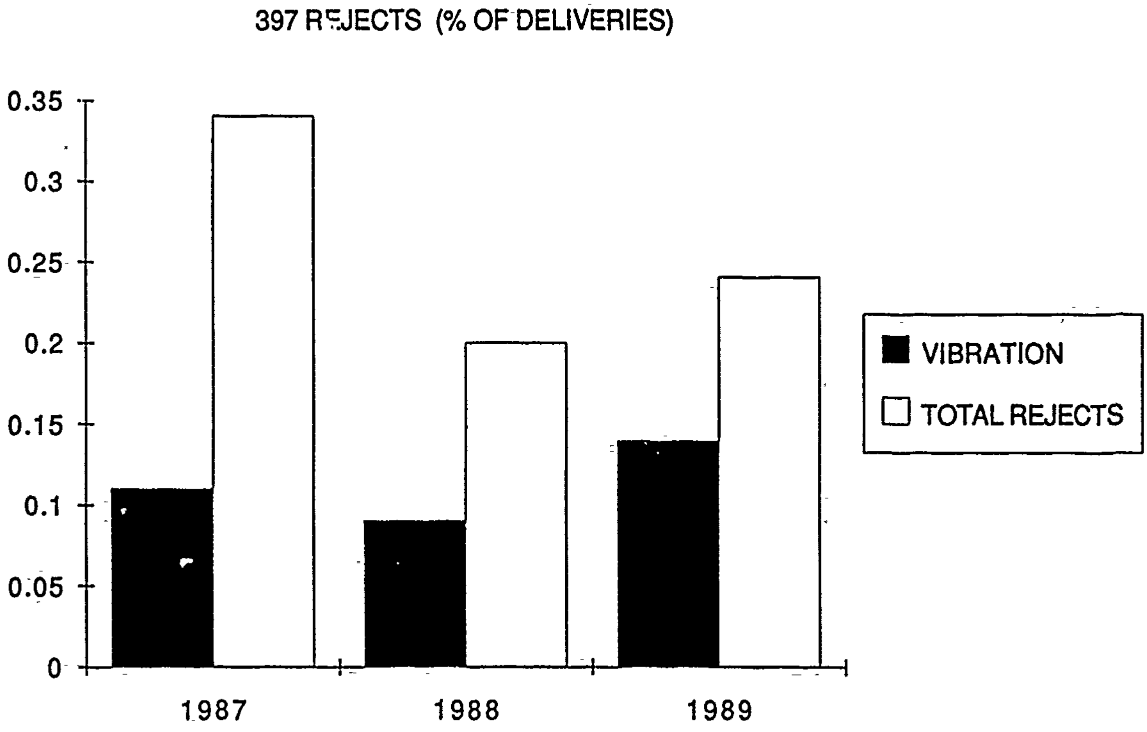

Chart #1

ENGINEERING NOTES

EMPLOYEE GARDNER DATE 19 Nov 90 PAGE NO. 5

RCC MATPUB SUBJECT Vibration Rejects

Ref: T.O. [illegible]

1st [illegible] compressor Diffuser Assy [illegible]

RECORD:

- 7 measurements for Dimensions A, B, and C each

- Dimension D
- Dimension E
- Dimension F

CALCULATE:

Average, variance and range for measurements of A, B, & C.

2nd Stage Impeller shroud Assy & 2nd Stage diffuser Housing

RECORD:

- 3 measurements of depth of 2nd Stage diffuser housing Assy
- [illegible] measurements of plate thickness
- Dimension A
3 measurements of distance from bar to 2nd stage compressor flange
- Dimension B
- shim thickness required (A - B + .005 inch)

Calculate:

Average, Variance, and Range for measurements

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE 10 Nov 90 PAGE NO. 2

RCC [illegible] SUBJECT Vibration Results

Record:

- Shaft runout

- shaft, impeller fit (may have to evaluate subjectively as good, bad, medium). Record the size mandrel used to fit parts.

- Shaft dimensions shown on Fig 1, pg 55 of TO 2G-GTCP85-53-7 WP00400 <u>Impeller Assy & Compressor Shaft Assy</u>

<u>Record:</u>

- Dimensions E, F, G, H, and J.

Calculate:

- Range & Variance of measurements used to find Dimension H

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6/6

ENGINEERING NOTES

EMPLOYEE [illegible] DATE 19 Nov 90 PAGE NO. 6

RCC [illegible] SUBJECT Vibration Reports

[illegible]

[illegible] :

Gap between Bearing and Compressor bearing retainer

Gap between 2nd stage Impeller & shroud

1st Stage Compressor Impeller Assy

Record :

- multiple values for Dimension L
- Average (Dimension L)

- Dimension Y
- Dimension Z (include value selected to add to Dim. Y)
- Total thickness of shims

Concentricity

Record:

- Bore Concentricity

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e. Balance. (See figure 2.)

NOTE

Tools called out in the following procedure are for use on a standard 1S or 13S Gisholt balancing machine.

(1) Balance in accordance with WP 003 00, paragraph 7.s.

(2) Mount impeller on 281890-1-1 arbor, tighten nut and torque to 50 inch-pounds and place in a balancing machine.

(3) Direct air on the impeller blades using 284383-1-1 drive assembly or belt drive.

(4) Balance shall be within 0.007 ounce-inch in planes L and M.

(5) Remove material, if required, from between blades item 1 within specified limits. Surfaces where material has been removed must blend smoothly and have a surface finish of 63 microinches or better.

(6) Remove material, if required, from item 2 within specified limits. Surfaces where material has been removed must blend smoothly and have a surface finish of 80 microinches or better.

(7) Remove material, if required, from blade corners item 3 within specified limits. Surfaces where material has been removed must blend smoothly and have a surface finish of 80 microinches or better.

(8) Remove material, if required, from item 4 within specified limits. Surfaces where material has been removed must blend smoothly and have a surface finish of 63 microinches or better.

(9) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(10) Corrosion treat reworked area in accordance with WP 003 00.

(11) Package in accordance with MIL-P-116 to prevent damage.

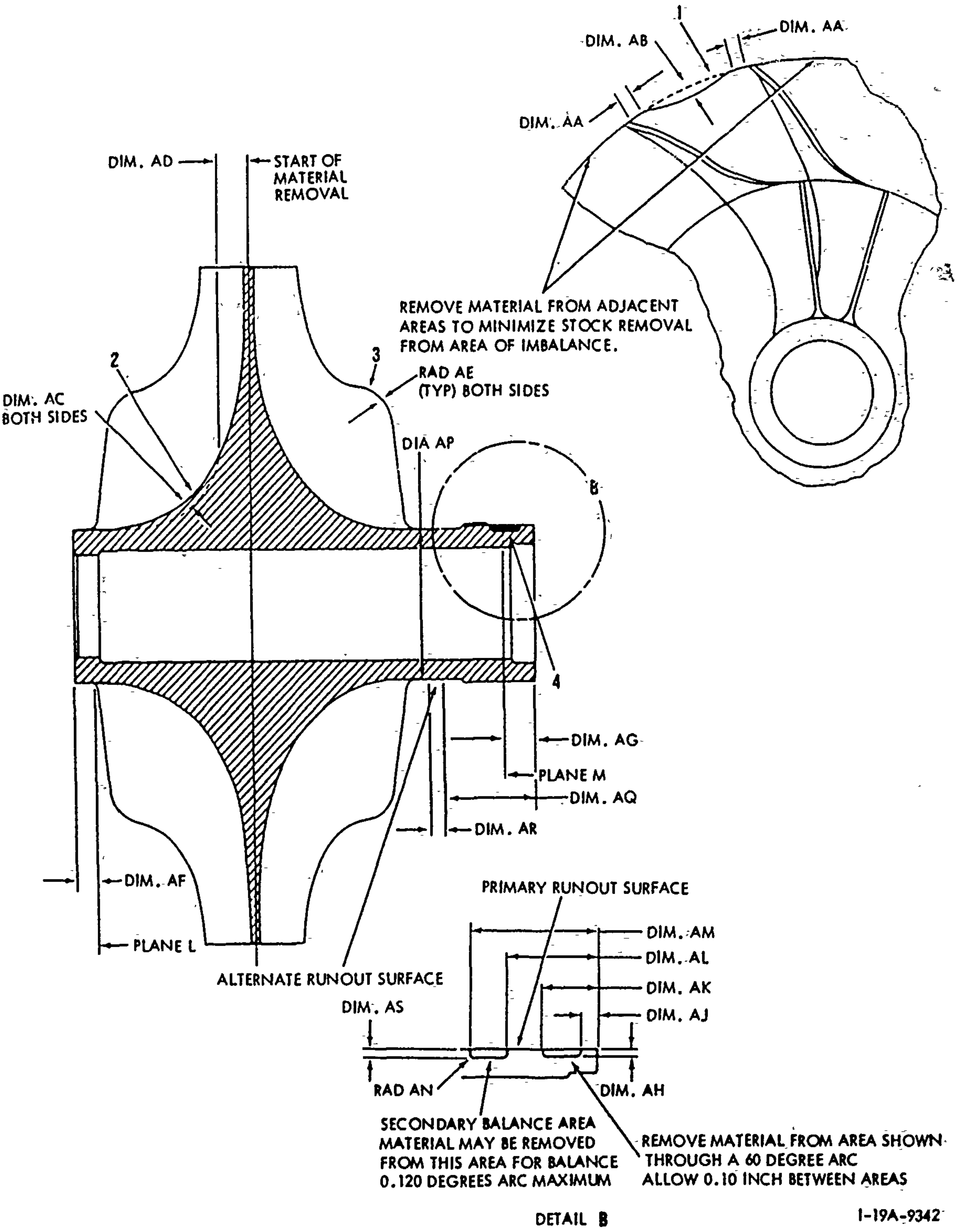
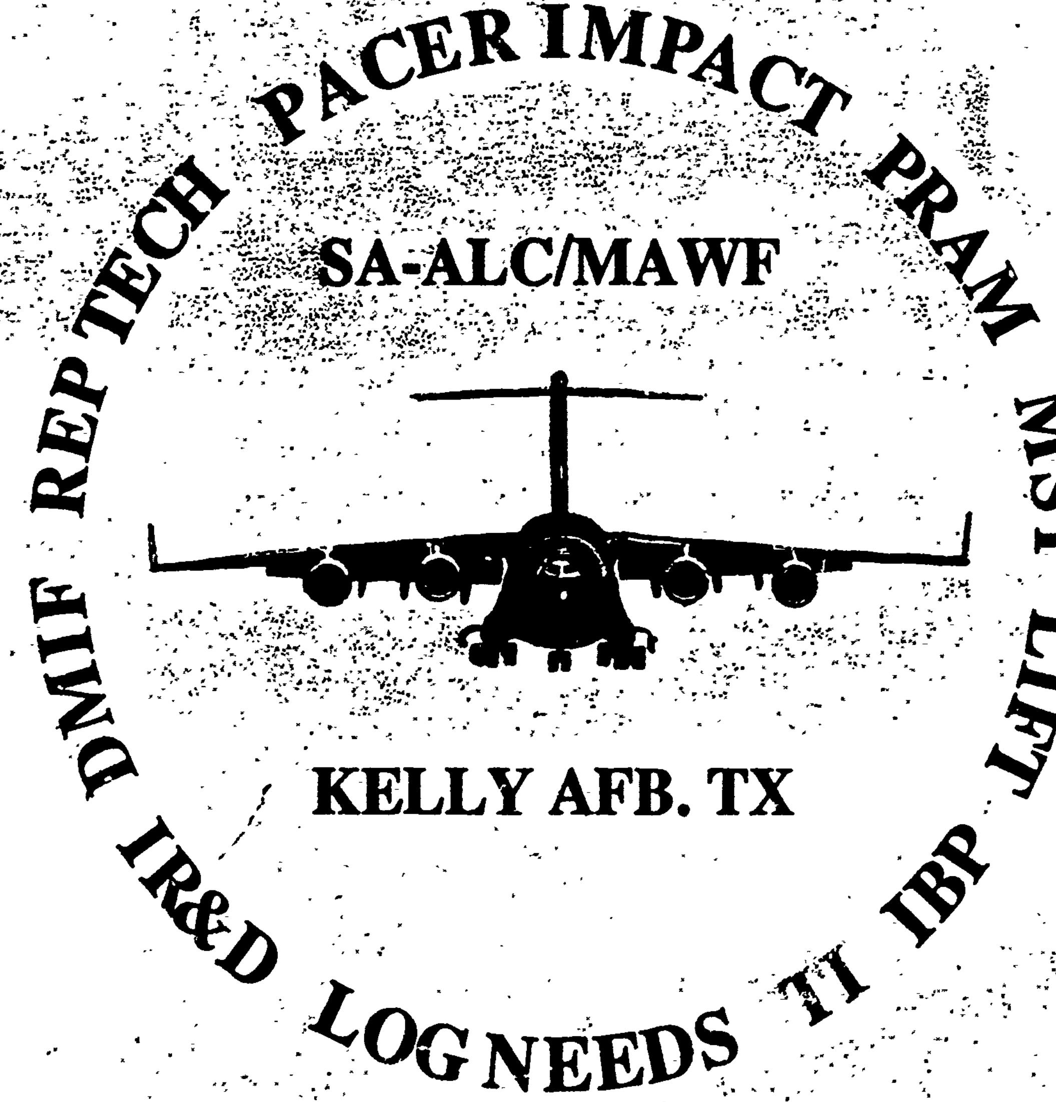

1
DIM. AB
DIM. AA
DIM. AA
DIM. AD
START OF MATERIAL REMOVAL
REMOVE MATERIAL FROM ADJACENT AREAS TO MINIMIZE STOCK REMOVAL FROM AREA OF IMBALANCE.
2
3
RAD AE (TYP) BOTH SIDES
DIM. AC BOTH SIDES
DIA AP
B
4
DIM. AG
PLANE M
DIM. AQ
DIM. AR
DIM. AF
PLANE L
ALTERNATE RUNOUT SURFACE
PRIMARY RUNOUT SURFACE
DIM. AM
DIM. AL
DIM. AK
DIM. AJ
DIM. AS
RAD AN
DIM. AH
SECONDARY BALANCE AREA MATERIAL MAY BE REMOVED FROM THIS AREA FOR BALANCE 0.120 DEGREES ARC MAXIMUM
REMOVE MATERIAL FROM AREA SHOWN THROUGH A 60 DEGREE ARC ALLOW 0.10 INCH BETWEEN AREAS
DETAIL B
1-19A-9342

Figure 2. First Stage Compressor Impeller (Impeller) - Balance

Dimensional Limits for Figure 2

DIM. AA	0.150 inch minimum
DIM. AB	0.400 inch maximum
DIM. AC	0.100 inch maximum
DIM. AD	0.32 to 0.38 inch
RAD AE	0.45 inch maximum
DIM. AF	0.25 inch maximum
DIM. AG	0.33 inch maximum
DIM. AH	0.050 inch maximum
DIM. AJ	0.130 inch minimum
DIM. AK	0.590 inch maximum
DIM. AL	0.770 inch minimum
DIM. AM	1.090 inch maximum
RAD AN	0.050 inch minimum
DIA AP	1.637 inch minimum
DIM. AQ	1.100 inches minimum
DIM. AR	0.120 to 0.140 inch
DIM. AS	0.090 inch maximum

SA-ALC-KAFBP 66-3
8 MAR 90



DIRECTORATE OF MAINTENANCE TECHNOLOGY INITIATIVES HANDBOOK
FY90

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2.15 (PROPOSED) WATER BLAST CLEANING SYSTEM

DESCRIPTION: Replacement of rubber seals on jet engine fan cases requires the prior removal of the old seal. Current methods include hand scraping, grit blasting, and solvent stripping. This project proposes to employ a robotic controlled high pressure water blaster to replace the labor intensive manual methods. The current method requires 2 1/2 hours per fan case while the proposed system will do a better job in about 25 minutes.

SCOPE: The new cell will utilize a programmable or manually positioned high pressure spray nozzle to direct a water blaster stream at components mounted on a turn table inside a spray booth. The system is totally enclosed to eliminate the possibility of injury to operating personnel.

FUND SOURCE: Proposed PRAM [redacted] IMPLEMENTATION DATE: TBD

POC: 1Lt Kurt Spilger, MATEC, AV 945-8521.

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5.6 (PROPOSED) MULTI-STATION PORTABLE BLENDING AND DEBURRING SYSTEM

DESCRIPTION: This system will augment the SA-ALC/MA Auto-Prompting Inspection Station (APIS). Each of the APISs will have its own blending and deburring system. These portable blending and deburring station will consist of individual hooded carts, which incorporate a grated work top with a vacuum system. The vacuum systems will eliminate the dispersion of dust particles into the working environment.

SCOPE: Parts received by the APIS require deburring to be accurately inspected. The inspector must often use tools to deburr or blend rough edges. As this operation is performed, tiny particles are dispersed into the air. These particles can cause serious malfunctions in the CMMs or the computer, rendering the inspection system inoperable.

FUND SOURCE: TBD IMPLEMENTATION DATE: TBD

POC: Manuel Diego, MATEA, AV 945-8885

ENGINEERING NOTES

EMPLOYEE Parker DATE 7/26/90 PAGE NO. 28

RCC GTE (All) SUBJECT GTE scheduling software

7/26/90 - Thursday

Scott Vroman, Ken Premo, and myself met with Danny Gonzales to discuss various points of interest in regard to the GTE task order. Mr. Gonzales had just returned from AFLC Headquarters, where he was successful in obtaining funding for an expert system/parts tracking package for the GTE area. We were all quite pleased to hear this, as we believe that this area could greatly benefit from such a system properly implemented. I was somewhat surprised at the aggressive schedule that was set for implementing this program. The hardware is to be installed and functional by Jan. 1, 1991, and the software and configuration is to be operational in April '91. As Mr. Gonzales pointed out, this will be a rigorous schedule. I hope that we can assist him as much as possible through our efforts in this area.

The following notes represent my understanding of the system. Anyone interested in more detailed information should contact Mr. Gonzales directly. As I understand it, the system to be installed has an AT&T 3B2 system at its heart, with 40 terminals placed throughout the GTE process area. The system will support bar code and automated tracking functions, and should allow data collection throughout the process, including the parts pool. The system is to be integrated with existing data systems, and all efforts will be made to configure it in support of DMMIS functions. The desired result, in addition to a more manageable production process, would be the ability to charge the user commands for actual hours expended on specific end items. The proposal presented to the AFLC personnel included an estimated ROI of 20:1, a proposed reduction in labor by 10%, and a reduction in stock items by 10%. The software system, and the contractor to be used in configuring this system, has not yet been identified.

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REPAIR TECHNOLOGY PROJECT

1. Title. Automated Fluorescent Penetrant Inspection Process (AFPIP)

2. Objective. The project will cover the automation of the entire process of Fluorescent Penetrant Inspection including the black light inspection. The computer will scan the surface of the aircraft part for any flaw. With the use of Artificial Intelligence, the computer will determine if the part is acceptable.

3. Cost of the Effort. Estimated AFSC MANTECH $ 1,500,000.00 needed to complete proposed project.

4. Description of the Technology Deficiencies:

a. Maintenance & Repair Operations:

(1) The Technology Repair Division is involved in the overhaul of 17 models of Aircraft Starters, 13 models of Gas Turbine Engines, the F15 Secondary Power System and the F16 Engine Start System. The Weapon Systems that are supported are: F100, B52, C135, A10, KC135, F4, F111, C130, F106, F101, C141, C140, C5, F15, & F16.

(2) The Maintenance Operation involves the overhaul of the assets mentioned in the preceding paragraph. The overhaul process includes disassembly, cleaning, fluorescent penetrant inspection, dimensional and visual inspection, repair (when needed), and assembly.

The required fluorescent penetrant inspection involves immersing a basket full of parts in 3 chemical filled tanks, water rinsing the parts twice under black light, drying the parts in electric dryers, and finally inspecting parts under black light (in a dark room) for cracks and imperfections.

b. Technology Deficiencies:

(1) There is no uniformity in the way black light inspection is being done. By automating this process, the computer will detect the flaws or cracks, quantify the crack, compare the results with technical order guidelines, and determine if flaw or crack is within or outside technical order guidelines.

(2) The chemicals are presently being replenished every month because of contamination or weakness in its concentration.

(3) Present set up exposes the operator to the hazards of the chemicals used in this process. Eliminating operator exposure to these chemicals will be a welcomed change.

(4) There is lack of uniformity in the application of the chemicals on parts in Bldg 329. There has excessive amount of penetrant in some instances and other times there is not enough of penetrant chemical.

(5) There is no uniformity in the rinsing process. This process is tedious in most cases. The operator has to work in a dark room with the black light on and rinse excess penetrant chemicals off the part.

(6) The present set up requires the operator to push baskets on the roller conveyor, attach the basket to the overhead conveyor for immersing in the chemical tanks, and lifting baskets from one station to another.

(7) This area is a bottleneck in Bldg 329, Kelly AFB. The volume of parts needing fluorescent penetrant inspection overwhelms the existing set up and the personnel involved in this process. These personnel are often requested to work overtime to catch up with the flow of parts.

c. Suggested Approach: A fully automated fluorescent penetrant inspection (FPI) line will resolve all the deficiencies that were discussed. The system will be similar to the IBIS in Bldg 360, Kelly AFB. The major difference is the automation of the black light inspection process. This will include a robotic arm that will pick up the part to be black light inspected, place it in the field of view of the fiber optic lens, detect flaw, quantify the flaw, evaluate the flaw, determine if flaw is acceptable with use of artificial intelligence, and print results of the inspection process. An automated material handling system will be used to move the baskets and most importantly to obtain the correct dwell time for the chemicals to cure. By utilizing electrostatic spray system in the application and dispensing of the chemicals, it will reduce chemical waste by an estimated 60%, eliminate personnel contact with the chemicals and have a uniformly applied coat of penetrant, remover and developer chemicals on the part.

5. Only existing system coming close to the suggested approach is the IBIS in Bldg 360, Kelly AFB. Item was contracted to General Electric. Project engineer for the IBIS is James Wheatley, 512 925 7716.

6. Policies and Procedures Guidance: All policies and guidance for the overhaul of the assets are provided by the technical order of each respective end item. Present process and procedure can be implemented by amending a statement in the technical orders which will allow electrostatic application of the chemicals.

7. Cost and Benefits:

a. Workload.	FY 89	Cartridge and Air Turbine Starters..	3,232 units
		Gas Turbine Engines..	1,174 units
		F-15 Secondary Power System..	1,681 units
		F-16 Engine Start System..	394 units
	FY 90	Cartridge and Air Turbine Starters..	952 units
		Gas Turbine Engines..	835 units
		F-15 Secondary Power System..	1,330 units
		F-16 Engine Start System..	400 units

The following items are projected workload:

FY 91	Cartridge and Air Turbine Starters..	852 units

RECOMMENDATIONS FOR FLUORESCENT PENETRANT INSPECTION (FPI)

PHASE I - PROCESS DATA

- Collect time data on FPI process steps and blacklight booth throughput.

- Develop process model.

- Determine what per cent of GTE parts get mandatory FPI.

- Determine what per cent of the remainder are receiving optional FPI.

- Determine what per cent of the parts receiving FPI have cracks.

- Determine how many cracked parts are condemned, how many are repaired, and how many are accepted as is.

- The above information is required to justify any further activity.

PHASE II - LOW TICKET IMPROVEMENTS (VERIFY BY PROCESS MODEL)

- Manual electrostatic spray booth for penetrant application (<50k). This will solve the chemical dragout problem but may not improve productivity.

- Switch from Level 3 sensitivity post emulsifiable penetrant system to a Level 3 or Level 4 sensitivity water washable penetrant. This will eliminate the hyrophilic remover and one rinse operation.

- Add a third blacklight booth. This will increase throughput and reduce the need for inspectors to spend twelve hours a day inside the booth. This leads to operator fatigue and the possibility of missed indications.

PHASE III - AUTOMATION

- If justified by the data, automation will be limited to the processing line.

- 95% of the interpretation in Bldg. 360 is performed by inspectors, not by the automated laser scanning system.

- Hardware configurations in Bldg. 329 are too varied and complex to lend themselves easily or economically to programming for laser scan.

- The current system of purchasing chemicals allows the possibility of combining different materials in the same tank. If this is actually happening, it should be stopped. Reliable and repeatable inspection depends on selecting a penetrant system and staying with it.

COLD JET, INC.
TRIP REPORT

GREG GARDNER
10/16/90

I Visited Cold Jet, Inc. (Cincinnati, OH) w/Sadie McFarland. The purpose of the visit was to evaluate the application of a CO_2 blasting process to cleaning engine parts. Sample parts from MAE and MAT were used to test the application of this technology to the current SA-ALC cleaning processes.

CO_2 blasting equipment is currently manufactured by two companies - Cold Jet and Alpheus. The Alpheus technology is older. It's cleaning action is based largely on kinetic energy imparted to the cleaning surface by the high-pressure impact of CO_2 pellets. Cold Jet's process is optimized for maximum thermal effects and places less emphasis on kinetics. Cold Jet uses a lower blast pressure and heavier pellet density than Alpheus. Both manufacturer's equipment is currently installed in AFLC.

Alpheus has a blast booth installed at OC-ALC. During MDMSC's evaluation of OC-ALC cleaning technology (1 Aug 90), OC-ALC engineers reported that the Alpheus process worked but required a chemical clean/strip prior to CO_2 blasting. The equipment was described as reliable and they complimented Alpheus on their customer support.

Cold Jet equipment has been purchased by WR-ALC and installation has begun. The equipment is not yet in use (due apparently to facilities problems - insufficient electrical wiring in the WR-ALC hangar), and MDMSC has no performance data.

In an unrelated effort, McDonnell Aircraft Company (McAir) conducted an evaluation of both vendors and recommended Cold Jet as the process of choice for aviation applications. A copy of this report was provided to MAE engineering staff.

The Cold Jet equipment consists of:

Cold Jet Blast Unit:

This unit produces the CO_2 pellets (from liquid CO_2) and provides nozzle pressure (regulated) for blasting. These units come in single, double, and triple nozzle configurations. The facilities foot print of these units is 4 x 6 (single) or 4 x 8 (double/triple). The input requirements are:

Electrical power (consumption rate UNK)
Liquid CO_2 (nominal temp = 0°F.)
Pressurized air (pressure is as required - max rating is 350 psi). This can be shop air or pressurized dry air or another inert gas.

These units are reported as highly reliable. While no MTBF/MTTR figures were immediately available, Cold Jet reported that 95% of all unscheduled failures were repairable in less than 20 min. The vendor provides a 1 year warranty, plus a 24 hour guarantee on return to service (a 24 hour hotline is maintained). The units are maintained on a 100 (operating) hour PM schedule.

MAX CO_2 consumption is 1400 lbs/hour.

Blast Nozzles:

The units are equipped with a broad assortment of nozzles for various applications. Nozzles can be customized to fit specific applications. The nozzles can be changed by the operator in 5 - 10 seconds without shutting down the unit (Blasting must stop, however, for safety reasons). The nozzles are connected to the blast unit by insulated cryogenic pressure hose. The nominal length for this hose is 60 - 100 ft but this can be increased to over 300 ft if necessary, or shortened as required.

Flow splitter units are available which allow one blast unit to deliver pellets through multiple nozzles or switch between nozzles as required. MDMSC saw a cleaning station designed for Ford, Inc. (stripping automobile conveyor carriers) that used one blast unit to support multiple nozzles in various arrangements. The plumbing was very involved but appeared well constructed.

Child Blast Unit

This is a portable unit which does not produce its own pellets. It stores pellets from a pelletizer or a blast unit and delivers them to the part. Those units contain about 700 lbs of CO_2 pellets.

CO_2 Tank Unit

The tank contains liquid CO_2 maintained at 0°F. This is pure (food-grade) CO_2 reclaimed by the manufacture (Liquid Carbonic) from other manufacturing processes. Delivery pressure is 300 psig.

Costs for this equipment was provided as:

Single Blast Unit	-	$ 150K
Double	-	$ 250K
Triple	-	$ 330K
Child	-	$ 50K

CO_2 2.5 ¢/lb delivered

Cold Jet reports their equipment is currently used by Delta, Northwest AL, Federal Express, and Boeing Corp.

A variety of parts were cleaned, with various degrees of success. The details of the cleaning process (and results) are documented on the video tape entitled "Cold Jet/MDMSC/IPI Test 16 Oct 90."

The process was extremely effective in removing grease, oils, heavy carbon/coking, gaskets and sealants, and paint from heavier - substrate items.

The process was less effective in removing primer from thin sheet metal parts, although it was able to accomplish this.

The process was ineffective at removing burnt carbon that had bonded with the metal substrate surface. It did not produce white metal.

- MDMSC will provide video and photo documentation on these parts to MAE/MAT engineers.

- The engine blade blasted will be shown to the MDMSC FPI expert whenever I can get him down here. We want to know if it could be inspected by a modified FPI process.

- Will ask Lisa Baumgardner to get details on NWA, Delta, and Fed Ex use of the technology (and how they really like it).

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PROD/NR  - 13082A          NOUN- MANIFOLD       PMS- F17  ERRC - T                      REPAIR        REQUIREMENTS
ACTUAL NSN- 4710010446143PT WSA - F100/200      MGR- 6AB                                COST    QTR  INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 4710010446143PT PSSD- MEPN9 C       IM - SA   EEII -    OWO   -    0        43.00   1      0        0         0        0
                                                          NOAF -    AWM   -    0        43.00   2      0        0         0        0
            EIDPSH     1.1 MIEC   - 07          FLOW  -    13       AWP   -    0        43.00   3      0        0         0        0
            ORGDPSH     .0 PSEUDO- FHCA         U/COST -    296.35  COND%-     0        43.00   4      0        0         0        0
CODE1 < > QTY1 <      > CODE2 < > QTY2 <      >                     S/M   - S                   FY     0        0         0        0

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PROD/NR  - 13083A          NOUN- ELEC ASS       PMS- WCC  ERRC - T                      REPAIR        REQUIREMENTS
ACTUAL NSN- 1190011292053CM WSA - MK12A         MGR- WMA                                COST    QTR  INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 1190011292053CM PSSD- MIRW9 W       IM - SA   EEII -    OWO   -    0       564.00   1      0        0         0        0
                                                          NOAF -    AWM   -    0       564.00   2      1        1         1        0
            EIDPSH    12.6 MIEC   - 04          FLOW  -    7        AWP   -    0       564.00   3      0        0         0        1
            ORGDPSH   12.6 PSEUDO- FCUN         U/COST -   5676.00  COND%-     0       564.00   4      0        0         0        0
CODE1 < > QTY1 <      > CODE2 < > QTY2 <      >                     S/M   - S                   FY     1        1         1        1

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PROD/NR  - 13084A          NOUN- CKTCDASS       PMS- MPD  ERRC - T                      REPAIR        REQUIREMENTS
ACTUAL NSN- 6625010460988DQ WSA - AN/FRR-98     MGR- UJK                                COST    QTR  INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 6625010460988DQ PSSD- MIRE9 C       IM - SA   EEII -    OWO   -    0      1674.00   1      0        0         0        0
                                                          NOAF -    AWM   -    0      1674.00   2      0        0         0        0
            EIDPSH    20.2 MIEC   - 16          FLOW  -    9        AWP   -    0      1674.00   3      0        1         0        1
            ORGDPSH   18.0 PSEUDO- FECL         U/COST -    890.24  COND%-    25      1674.00   4      0        0         0        0
CODE1 < > QTY1 <      > CODE2 < > QTY2 <      >                     S/M   - S                   FY     0        1         0        1

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PROD/NR  - 13093A          NOUN- CCA            PMS- WBB  ERRC - T                      REPAIR        REQUIREMENTS
ACTUAL NSN- 1190011074607CM WSA - MHU-173/M     MGR- WCA                                COST    QTR  INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 1190011074607CM PSSD- MIRW9 W       IM - SA   EEII -    OWO   -    1       381.00   1      1        1         0        0
                                                          NOAF -    AWM   -    0       381.00   2      0        0         0        0
            EIDPSH     9.1 MIEC   - 04          FLOW  -    6        AWP   -    0       381.00   3      0        0         0        0
            ORGDPSH    9.1 PSEUDO- FCUN         U/COST -   1066.30  COND%-    20       381.00   4      0        0         0        0
CODE1 < > QTY1 <      > CODE2 < > UTY2 <      >                     S/M   - S                   FY     1        1         0        0

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PROD/NR  - 13094A          NOUN- GT85-897       PMS- PEL  ERRC - T                      REPAIR        REQUIREMENTS
ACTUAL NSN- 2835012422189  WSA - A-M32A-60      MGR- VEA                                COST    QTR  INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 2835012422189  PSSD- MTPG9 E        IM - SA   EEII -    OWO   -   78     30985.00   1     60       51        48       46
                                                          NOAF -    AWM   -   18     30985.00   2     46       46        46       46
            EIDPSH   390.0 MIEC   - 04          FLOW  -  [illegible] AWP   -    0     30985.00   3      0       50         0       42
            ORGDPSH   78.6 PSEUDO- FHNS         U/COST -  73,123.00 COND%-     0     30985.00   4     15       28        15        0
CODE1 < > QTY1 <      > CODE2 < > QTY2 <      >                     S/M   - S                   FY   121      175       109      134

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PROD/NR  - 13095A          NOUN- GT86/397       PMS- PEL  ERRC - T                      REPAIR        REQUIREMENTS
ACTUAL NSN- 2835012410074  WSA - A-M32A-60A     MGR- VEG                                COST    QTR  INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 2835012428063  PSSD- MTPG9 E        IM - SA   EEII -    OWO   -   54     33407.00   1     30       18        29       18
                                                          NOAF -    AWM   -   21     33407.00   2     20       30        18       30
            EIDPSH   355.7 MIEC   - 01          FLOW  -    39       AWP   -    0     33407.00   3     20       34        17       21
            ORGDPSH   87.8 PSEUDO- FHNS         U/COST -  76000.00  COND%-     0     33407.00   4     59       67        30        4
CODE1 < > QTY1 <      > CODE2 < > QTY2 <      >                     S/M   - S                   FY   129      149        94       73
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PROD/NR    - 13082A          NOUN- MANIFOLD     PMS- F17  ERRC - T                        REPAIR          REQUIREMENTS
ACTUAL NSN- 4710010446143PT  WSA - F100/200     MGR- BAB                                   COST   QTR   INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 4710010446143PT  PSSD- MEPN9 C      IM - SA   EEII -      OWO   -     0       43.00  1         0        0         0        0
                                                          NOAF -      AWM   -     0       43.00  2         0        0         0        0
           EIDPSH       1.1  MIEC  - 07         FLOW   -   13         AWP   -     0       43.00  3         0        0         0        0
          ORGDPSH        .0  PSEUDO- FHCA       U/COST -   296.35     CONDX-      0       43.00  4         0        0         0        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <     >                       S/M   - S                  FY        0        0         0        0

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PROD/NR    - 13083A          NOUN- ELEC ASS     PMS- WCC  ERRC - T                        REPAIR          REQUIREMENTS
ACTUAL NSN- 1190011292053CM  WSA - MK12A        MGR- WMA                                   COST   QTR   INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 1190011292053CM  PSSD- MIRW9 W      IM - SA   EEII -      OWO   -     0      564.00  1         0        0         0        0
                                                          NOAF -      AWM   -     0      564.00  2         1        1         1        0
           EIDPSH      12.6  MIEC  - 04         FLOW   -   7          AWP   -     0      564.00  3         0        0         0        1
          ORGDPSH      12.6  PSEUDO- FCUN       U/COST -   5676.00    CONDX-      0      564.00  4         0        0         0        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <     >                       S/M   - S                  FY        1        1         1        1

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PROD/NR    - 13084A          NOUN- CKTCDASS     PMS- MPD  ERRC - T                        REPAIR          REQUIREMENTS
ACTUAL NSN- 6625010460988DQ  WSA - AN/FRR-98    MGR- UJK                                   COST   QTR   INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 6625010460988DQ  PSSD- MIRE9 C      IM - SA   EEII -      OWO   -     0     1674.00  1         0        0         0        0
                                                          NOAF -      AWM   -     0     1674.00  2         0        0         0        0
           EIDPSH      20.2  MIEC  - 16         FLOW   -   9          AWP   -     0     1674.00  3         0        1         0        1
          ORGDPSH      18.0  PSEUDO- FECL       U/COST -   890.24     CONDX-     25     1674.00  4         0        0         0        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <     >                       S/M   - S                  FY        0        1         0        1

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PROD/NR    - 13093A          NOUN- CCA          PMS- WBB  ERRC - T                        REPAIR          REQUIREMENTS
ACTUAL NSN- 1190011074807CM  WSA - MHU-173/M    MGR- WCA                                   COST   QTR   INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 1190011074807CM  PSSD- MIRW9 W      IM - SA   EEII -      OWO   -     1      381.00  1         1        1         0        0
                                                          NOAF -      AWM   -     0      381.00  2         0        0         0        0
           EIDPSH       9.1  MIEC  - 04         FLOW   -   6          AWP   -     0      381.00  3         0        0         0        0
          ORGDPSH       9.1  PSEUDO- FCJN       U/COST -   1066.30    CONDX-     20      381.00  4         0        0         0        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <     >                       S/M   - S                  FY        1        1         0        0

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PROD/NR    - 13094A          NOUN- OT85-397     PMS- PEL  ERRC - T                        REPAIR          REQUIREMENTS
ACTUAL NSN- 2835012422189    WSA - A-M32A-60    MGR- VEA                                   COST   QTR   INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 2835012422189    PSSD- MTPG9 E      IM - SA   EEII -      OWO   -    78    30985.00  1        60       51        48       46
                                                          NOAF -      AWM   -    18    30985.00  2        46       46        46       46
           EIDPSH     390.0  MIEC  - 04         FLOW   -   40         AWP   -     0    30985.00  3         0       50         0       42
          ORGDPSH      78.6  PSEUDO- FHNS       U/COST -   73123.00   CONDX-      0.   30985.00  4        15       28        15        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <     >                       S/M   - S                  FY      121      175       109      134

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PROD/NR    - 13095A          NOUN- G180/397     PMS- PEL  ERRC - T                        REPAIR          REQUIREMENTS
ACTUAL NSN- 2835012410074    WSA - A-M32A-60A   MGR- VEG                                   COST   QTR   INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 2835012428063    PSSD- MTPG9 E      IM - SA   EEII -      OWO   -    54    33407.00  1        30       18        29       18
                                                          NOAF -      AWM   -    21    33407.00  2        20       30        18       30
           EIDPSH     355.7  MIEC  - 01         FLOW   -   39         AWP   -     0    33407.00  3        20       34        17       21
          ORGDPSH      87.8  PSEUDO- FHNS       U/COST -   78000.00   CONDX-      0    33407.00  4        59       67        30        4
CODE1 < > QTY1 <       > CODE2 < > QTY2 <     >                       S/M   - S                  FY      129      149        94       73
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SOR MISTR MASTER (PROD/NR)          AS OF 19 JUL 90      SOR SA                                                                A-G019C-CAJ-CA-8CS
**************************          PERIOD 22            FISCAL YEAR 90                                                                 PAGE  478

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PROD/NR    - 13082A                NOUN- MANIFOLD        PMS- F17   ERRC - T                              REPAIR           REQUIREMENTS
ACTUAL NSN- 4710010446143PT        WSA - F100/200        MGR- BAB                                          COST   QTR     INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 4710010446143PT        PSSD- MEPN9 C         IM - SA    EEII -      OWO   -      0           43.00   1          0        0         0        0
                                                                    NOAF -      AWM   -      0           43.00   2          0        0         0        0
            EIDPSH      1.1  MIEC   - 07                 FLOW    -    13        AWP   -      0           43.00   3          0        0         0        0
            ORGDPSH      .0  PSEUDO- FHCA                U/COST  -    296.35    CONDX-       0           43.00   4          0        0         0        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <      >                                S/M   - S                        FY         0        0         0        0
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PROD/NR    - 13083A                NOUN- ELEC ASS        PMS- WCC   ERRC - T                              REPAIR           REQUIREMENTS
ACTUAL NSN- 1190011292053CM        WSA - MK12A           MGR- WMA                                          COST   QTR     1.IPUT  OUTPUT    INDUCT  PRODUCT
MASTER NSN- 1190011292053CM        PSSD- MIRW9 W         IM - SA    EEII -      OWO   -      0          564.00   1          0        0         0        0
                                                                    NOAF -      AWM   -      0          564.00   2          1        1         1        0
            EIDPSH     12.6  MIEC   - 04                 FLOW    -     7        AWP   -      0          564.00   3          0        0         0        1
            ORGDPSH    12.6  PSEUDO- FCUN                U/COST  -   5676.00    CONDX-       0          564.00   4          0        0         0        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <      >                                S/M   - S                        FY         1        1         1        1
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PROD/NR    - 13084A                NOUN- CKTCDASS        PMS- MPD   ERRC - T                              REPAIR           REQUIREMENTS
ACTUAL NSN- 6625010460988DQ        WSA - AN/FRR-98       MGR- UJK                                          COST   QTR     INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 6625010460988DQ        PSSD- MIRE9 C         IM - SA    EEII -      OWO   -      0         1674.00   1          0        0         0        0
                                                                    NOAF -      AWM   -      0         1674.00   2          0        0         0        0
            EIDPSH     20.2  MIEC   - 16                 FLOW    -     9        AWP   -      0         1674.00   3          0        1         0        1
            ORGDPSH    18.0  PSEUDO- FECL                U/COST  -    890.24    CONDX-      25         1674.00   4          0        0         0        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <      >                                S/M   - S                        FY         0        1         0        1

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PROD/NR    - 13093A                NOUN- CCA             PMS- WBB   ERRC - T                              REPAIR           REQUIREMENTS
ACTUAL NSN- 1190011074607CM        WSA - MHU-173/M       MGR- WCA                                          COST   QTR     INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 1190011074607CM        PSSD- MIRW9 W         IM - SA    EEII -      OWO   -      1          381.00   1          1        1         0        0
                                                                    NOAF -      AWM   -      0          381.00   2          0        0         0        0
            EIDPSH      9.1  MIEC   - 04                 FLOW    -     6        AWP   -      0          381.00   3          0        0         0        0
            ORGDPSH     9.1  PSEUDO- FCJN                U/COST  -   1066.30    CONDX-      20          381.00   4          0        0         0        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <      >                                S/M   - S                        FY         1        1         0        0

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PROD/NR    - 13094A                NOUN- GT85-397        PMS- PEL   ERRC - T                              REPAIR           REQUIREMENTS
ACTUAL NSN- 2835012422189          WSA - A-M32A-60       MGR- VEA                                          COST   QTR     INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 2835012422189          PSSD- MTPG9 E         IM - SA    EEII -      OWO   -     78        30985.00   1         60       51        48       46
                                                                    NOAF -      AWM   -     18        30985.00   2         46       46        46       46
            EIDPSH    390.0  MIEC   - 04                 FLOW    -   (40)       AWP   -      0        30985.00   3          0       50         0       42
            ORGDPSH    78.6  PSEUDO- FHNS                U/COST  -  73123.00    CONDX-       0        30985.00   4         15       28        15        0
CODE1 < > QTY1 <       > CODE2 < > QTY2 <      >                                S/M   - S                        FY       121      175       109      134
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PROD/NR    - 13095A                NOUN- G180/397        PMS- PEL   ERRC - T                              REPAIR           REQUIREMENTS
ACTUAL NSN- 2835012410074          WSA - A-M32A-60A      MGR- VEG                                          COST   QTR     INPUT   OUTPUT    INDUCT  PRODUCT
MASTER NSN- 2835012428063          PSSD- MTPG9 E         IM - SA    EEII -      OWO   -     54        33407.00   1         30       18        29       18
                                                                    NOAF -      AWM   -     21        33407.00   2         20       30        18       30
            EIDPSH    355.7  MIEC   - 01                 FLOW    -   (39)       AWP   -      0        33407.00   3         20       34        17       21
            ORGDPSH    87.8  PSEUDO- FHNS                U/COST  -  78000.00    CONDX-       0        33407.00   4         59       67        30        4
CODE1 < > QTY1 <       > CODE2 < > QTY2 <      >                                S/M   - S                        FY       129      149        94       73
```

Attachment · 49A

GENERIC

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SUBJECT GTE 85-180 **FLOW PROCESS CHART** Inspection DATE 6/2/89

ITEM CODE
PCN ☑
NSN ☐ 13095 A
P/N ☐

WCD G II I WCD DATE 89152

CHART BEGINS 010

CHART ENDS 110 PREPARED BY Jim Eaton

OP. PROFILE OP. NO.	WCD OP. NO.	SYMBOLS	DESCRIPTION	OP. PROFILE OP. NO.	WCD OP. NO.	SYMBOLS	DESCRIPTION
010	010	○▷D■▽	Insp VIS			○▷D□▽	
020	020	○▷D■▽	Insp FPI			○▷D□▽	
030	030	○▷D■▽	Insp DIM			○▷D□▽	
040	040	○▷D■▽	Insp DIM			○▷D□▽	
050	050	○▷D■▽	Insp DIM			○▷D□▽	
060	060	○▷D■▽	Insp DIM			○▷D□▽	
070	070	○▷D■▽	Insp MAG			○▷D□▽	
080	080	○▶D□▽	Route-Parts			○▷D□▽	
090	090	○▶D□▽	Route-R/S			○▷D□▽	
100	100	●▷D□▽	Grit Blast			○▷D□▽	
110	110	○▶D□▽	Route - Part			○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	

○ OPERATION ▽ STORAGE □ INSPECTION
▷ TRANSPORTATION D DELAY

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ENGINEERING NOTES

EMPLOYEE Parker DATE 6/24/90 PAGE NO. 65

RCC GTE (61) SUBJECT 13094A parts

MATPSI

Item	(I) CLN	(II) Insp
2nd Stage diffuser assy.	.22 hr 24.0 hr MF	AF = 1.5 FPI – prc = .17 V.'s – prec = .17 Dim – prec = .33 MATPNC = .50 (OF) $\begin{pmatrix} (.05) & (.90) & (.05) \\ 360 & 600 & 840 \end{pmatrix}$ CLN – .17
Turbine Torus	.24 hr 24.0 hr MF	V.s – .17 V.'s – .17 dim – .50
Turbine nozzle	.20 hr 24.0 hr MF	V.'s .02 V.'s .02 V.'s .33 V.'s .17

Turbine Plenum	.25 hr
	24.0 hr MF
		MF = 1.5
		FPI – prec = .11
		V.'s – .17
		MANSM = $\begin{pmatrix} (.05) & (.90) & (.05) \\ 360 & 600 & 840 \end{pmatrix}$

* Generic GTE 85 395	cln = .17 cln = .17 Air dry = 24.0 MF	Total Insp : 1.51 hr Part pool = .60 sorted B/S = .40 $\begin{pmatrix} (.05) & (.90) & (.05) \\ 240 & 360 & 480 \end{pmatrix}$ MATPSI CLN = .30 (.17)

DDB SECTION CODE

DDB PAGE NO.

335

Note – start tracking in cool down area MATPSI.

GTE 13094A

GENERIC OPERATION PROFILE Inspection

NAME Jim Eaton ALC SA DATE 5/26/89 RCC MATPSI SHEET 1 OF 3

(PCN) NSN 13094A WCD G10I WCD DATE 89152

P/N

OPERATION NUMBER	RCC	OPERATION DESCRIPTION	MANDATORY OCCURRENCE FACTOR	OPERATION TYPE	MANDATORY FLOW HOURS		MANPOWER				EQUIPMENT				DATA SOURCE COMMENTS
							SKILL CODE/ LEVEL	QTY.	TIME REQUIRED		EQUIPMENT CODE	QTY.	TIME REQUIRED		
					%	HRS.			%	HRS.			%	HRS.	
010	MAT PSI	FPI	.30	~~TRANSIT~~											R. Hernandez
				~~SETUP~~											
				PROCESS	100	1.5	5439 DD09	1	100	.17	NDI-23	1	100	.17	
020		VIS	1.0	~~TRANSIT~~											G. Chacon
				~~SETUP~~											
				PROCESS			5439 DD09	1	100	.17					
030		DIM	.40	~~TRANSIT~~											G. Chacon
				~~SETUP~~											
				PROCESS			5439 DD09	1	100	.33	NDI-1	1	100	.33	
040		DIM	.10	~~TRANSIT~~											G. Chacon
				~~SETUP~~											
				PROCESS			5439 DD09	1	100	.50	NDI-2	1	100	.50	
050		DIM	.10	~~TRANSIT~~											G. Chacon
				~~SETUP~~											
				PROCESS			5439 DD09	1	100	.33	NDI-5	1	100	.33	

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G

Generic OPERATIC PROFILE Inspection

NAME Jim Eaton ALC JA DATE 5/26/89 RCC MATPSI SHEET 2 OF 3

PCN/NSN/P/N 13094A WCD G10I WCD DATE 89152

OPERATION NUMBER	RCC	OPERATION DESCRIPTION	MANDATORY OCCURRENCE FACTOR	OPERATION TYPE	MANDATORY FLOW HOURS %	MANDATORY FLOW HOURS HRS.	MANPOWER SKILL CODE/ LEVEL	MANPOWER QTY.	MANPOWER TIME REQUIRED %	MANPOWER TIME REQUIRED HRS.	EQUIPMENT CODE	EQUIPMENT QTY.	EQUIPMENT TIME REQUIRED %	EQUIPMENT TIME REQUIRED HRS.	DATA SOURCE COMMENTS
060	MAT PSI	DIM	.04	~~TRANSIT~~											G. Chacon
				~~SETUP~~											
				PROCESS			5439 DD09	1	100	.25	NDI-14	1	100	.25	
070	MAT PSI	MAG	.50	~~TRANSIT~~											
				~~SETUP~~											
				PROCESS			5439 DD09	1	100	.08	NDI 25	1	100	.08	
080	MAT SE	RTE	.60	~~TRANSIT~~											Route to Parts Pool
				~~SETUP~~											
				PROCESS											
090	MAT SA	RTE	.40	~~TRANSIT~~ P	.05	240									Route to Back Shops
				~~SETUP~~ T	.80	360									
				PROCESS	.05	480									
100	MAT PSI	CLN	.30	~~TRANSIT~~											
				~~SETUP~~											
				PROCESS			5420 4D05	1	100	.17	CLN-4	1	100	.17	

LSC-2(XY)2C

OPERATION PROFILE

NAME Jim Eaton ALC SA DATE 5/26/89 RCC MATPSI SHEET 3 OF 3

(PCH) NSN 13094A WCD G10I WCD DATE 89152

P/N

OPERATION NUMBER	RCC	OPERATION DESCRIPTION	MANDATORY OCCURRENCE FACTOR	OPERATION TYPE	INVENTORY FLOW HOURS %	INVENTORY FLOW HOURS HRS.	MANPOWER SKILL CODE/ LEVEL	MANPOWER QTY.	MANPOWER TIME REQUIRED %	MANPOWER TIME REQUIRED HRS.	EQUIPMENT CODE	EQUIPMENT QTY.	EQUIPMENT TIME REQUIRED %	EQUIPMENT TIME REQUIRED HRS.	DATA SOURCE COMMENTS
110	MAT SE	RTE	.30	TRANSIT											Route to parts
				SETUP											
				PROCESS											
				TRANSIT											
				SETUP											
				PROCESS											
				TRANSIT											
				SETUP											
				PROCESS											
				TRANSIT											
				SETUP											
				PROCESS											
				TRANSIT											
				SETUP											
				PROCESS											

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LSC-2

GENERIL 41

SUBJECT GTE 85-397 **FLOW PROCESS CHART** Inspection DATE 5/30/87

ITEM CODE
PCN ☑
NSN ☐ 13094 A
P/N ☐

WCD G10I WCD DATE 89152

CHART BEGINS 010

CHART ENDS 110 PREPARED BY Jim Eaton

OP. PROFILE OP. NO.	WCD OP. NO.	SYMBOLS	DESCRIPTION	OP. PROFILE OP. NO.	WCD OP. NO.	SYMBOLS	DESCRIPTION
010	010	○▷D■▽	Insp FPI			○▷D□▽	
020	020	○▷D■▽	Insp VIS			○▷D□▽	
030	030	○▷D■▽	Insp DIM			○▷D□▽	
040	040	○▷D■▽	Insp DIM			○▷D□▽	
050	050	○▷D■▽	Insp DIM			○▷D□▽	
060	060	○▷D■▽	Insp DIM			○▷D□▽	
070	070	○▷D■▽	Insp MAG			○▷D□▽	
080	080	○▶D□▽	Route - Parts			○▷D□▽	
090	090	○▶D□▽	Route - B/S			○▷D□▽	
100	100	○▷D□▽	Grit Blast			○▷D□▽	
110	110	○▷D□▽	Route - Parts			○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	
		○▷D□▽				○▷D□▽	

○ OPERATION ▽ STORAGE □ INSPECTION
▷ TRANSPORTATION D DELAY

LSC-20147

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ENGINEERING NOTES

EMPLOYEE Parker
DATE 6/24/90
PAGE NO. 66
RCC GTE ally
SUBJECT 13095A parts insp.

MATPSI

Item	(I) clN	(II) Insp	
Accessory Case	.33 hr	FPI -	MF: 1.5 Proc = .17
	24.0 hr MF	V.S -	.17
		D.m -	,5
		mini B/S -	((.05) 240 (.50) 360. (.05) 600)
		MATPSI CLN -	.06
		cln -	,17
Combustion chamber lining	.13 hr	V.S -	,17
	24.0 hr MF	V.S -	.17
		D.m -	,50
Turbin Torus	.13 hr	FPI -	MF: 1.5 P = .17
	24.0 hr MF	V.S -	,17
		V.S -	,17
		V.S -	,08
		D.m -	,5
wheel & Shaft Assy	,21 hr	FPI -	MF - 1.5 P - ,17
	24.0 hr MF	V.S -	,08
		V.S -	.08
		V.S -	,02
		V.S -	,02
		V.S -	,02
		V.S -	,02
		V.S -	,02
		V.S -	,02
		V.S -	,02
		D.m -	,50
		D.m -	,3.3

DDB SECTION CODE ______

DDB PAGE NO. ______

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ENGINEERING NOTES

EMPLOYEE Clarke
DATE 8/24/90
PAGE NO. 67
RCC GTE (611)
SUBJECT 13095 A

MATPSI

Item	CLN	INSP		OF
*Generic	.34 hr	Vis -	..17	(1.0)
	24.0 hr MF	FPI -	1.5 MF .17 P	(.40)
		DIM -	.5	(.40)
		DIM -	.5	(.10)
		DIM -	.33	(.10)
		DIM -	.33	(.01)
		MAG -	.08	(.50)
		B/S -	.40	((.05) 240 (.90) 360 (.05) 480)
		Port Pnl -	.60	QF sent here
		CLN -	.25	(.40)

DDB SECTION CODE ____________ DDB PAGE NO. ____________

341

G+F 85-180 13095A GENERIC

OPERATION PROFILE Inspection

C.V.

NAME Jim Eaton ALC SA DATE 5/30/89 RCC MATPSI SHEET 1 OF 3

PCN 13095A
NSN
P/N

WCD G II I WCD DATE 89152

OPERATION NUMBER	RCC	OPERATION DESCRIPTION	MANDATORY OCCURRENCE FACTOR	OPERATION TYPE	MANDATORY FLOW HOURS %	MANDATORY FLOW HOURS HRS.	MANPOWER SKILL CODE/ LEVEL	MANPOWER QTY.	MANPOWER TIME REQUIRED %	MANPOWER TIME REQUIRED HRS.	EQUIPMENT CODE	EQUIPMENT QTY.	EQUIPMENT TIME REQUIRED %	EQUIPMENT TIME REQUIRED HRS.	DATA SOURCE COMMENTS
010	MAT PSI	VIS	1.0	TRANSIT											G Chacon
				SETUP											
				PROCESS			5439 DD09	1	100	.17					
020		FPI	0.40	TRANSIT											R. Hernandez
				SETUP											
				PROCESS	100	1.5	5439 DD09	1	100	.17	NDI-23	1	100	.17	
030		DIM	.40	TRANSIT											G. Chacon
				SETUP											
				PROCESS			5439 DD09	1	100	.50	NDI-1	1	100	.50	
040		DIM	.10	TRANSIT											G. Chacon
				SETUP											
				PROCESS			5439 DD09	1	100	.50	NDI-2	1	100	.50	
050		DIM	.10	TRANSIT											G. Chacon
				SETUP											
				PROCESS			5439 DD09	1	100	.33	NDI-5	1	100	.33	

Mag. .40

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LSC-20092C

44

G

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OPERATION PROFILE

NAME Jim Eaton ALC SA DATE 5/30/89 RCC MATP SHEET 2 OF 3

PCN NSN P/N 13095A WCD G11I WCD DATE 89152

OPERATION NUMBER	RCC	OPERATION DESCRIPTION	MANDATORY OCCURRENCE FACTOR	OPERATION TYPE	MANDATORY FLOW HOURS %	MANDATORY FLOW HOURS HRS.	MANPOWER SKILL CODE/ LEVEL	MANPOWER QTY.	MANPOWER TIME REQUIRED %	MANPOWER TIME REQUIRED HRS.	EQUIPMENT CODE	EQUIPMENT QTY.	EQUIPMENT TIME REQUIRED %	EQUIPMENT TIME REQUIRED HRS.	DATA SOURCE COMMENTS
060	MAT PSI	DIM	.01	TRANSIT											G. Checon
				SETUP											
				PROCESS			5439 DD09	1	100	.33	NAI-14	1	100	.33	
070	MAT PSI	MAG	.50	TRANSIT											
				SETUP											
				PROCESS			5439 DD09	1	100	.08	NAI 25	1	100	.08	
080	MAT SE	RTE	.60	~~TRANSIT~~											Route to Parts Pool
				~~SETUP~~											
				PROCESS											
090	MAT SN	RTE	1.40	~~TRANSIT~~ P	.05	240									Route to Back Shop
				~~SETUP~~ P	.90	360									
				PROCESS	.05	480									
100	MAT PSI	CLN	.40	TRANSIT											G. Jones
				SETUP											
				PROCESS			7004 4D05	1	100	.25					

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LSC-20092C

OPERATION PROFILE

NAME Jim Eaton ALC JA DATE 5/30/89 RCC MATSI SHEET 3 OF 3

PCN / NSN / P/N 13095A WCD G11I WCD DATE 89152

OPERATION NUMBER	RCC	OPERATION DESCRIPTION	MANDATORY OCCURRENCE FACTOR	OPERATION TYPE	MANDATORY FLOW HOURS		MANPOWER				EQUIPMENT				DATA SOURCE COMMENTS
					%	HRS.	SKILL CODE/ LEVEL	QTY.	TIME REQUIRED %	TIME REQUIRED HRS.	EQUIPMENT CODE	QTY.	TIME REQUIRED %	TIME REQUIRED HRS.	
110	MAT SE	RTE	1.0	TRANSIT											Route to Parts Pool
				SETUP											
				PROCESS											
				TRANSIT											
				SETUP											
				PROCESS											
				TRANSIT											
				SETUP											
				PROCESS											
				TRANSIT											
				SETUP											
				PROCESS											
				TRANSIT											
				SETUP											
				PROCESS											

LSC-2(X)92C

Attach. 59A

AS OF FY - 85

ITEM DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV.	DEC	
GTCP 165-1	0	0	0	0	0	0	1	0	0	1	0	2	
GTC 85-56	1	6	3	5	5	5	6	6	4	3	2	3	
GTC 85-72	21	16	15	15	43	50	34	45	35	21	13	13	
GTC 85-116	1	0	0	0	1	0	0	0	1	0	0	1	
GTCP 85-180L	1	0	0	1	2	0	1	1	2	0	1	0	
GTC 85-70	13	16	17	12	16	30	26	27	31	18	16	12	
GTCP 85-397	18	14	6	18	31	45	31	31	31	15	15	16	
GTCP 85-180	17	18	15	26	50	40	33	19	24	14	10	9	
GTCP 85-180-7													
GTCP 85-71A	11	13	8	13	18	31	21	21	18	21	13	6	
T41M9A	9	11	15	7	11	0	0	0	0	8	13	11	
GTCP 85-106	0	1	0	0	0	0	3	1	0	0	0	0	
GTCP 36-50	0	0	0	0	0	0	0	0	1	0	0	0	

Attach. 59B

AS OF FY-86

ITEM DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV.	DEC	TOTAL
GTCP 165-1	0	2	1	1	2	0	0	1	2	0	0	0	9
GTC 85-56	2	4	6	5	7	2	3	5	5	5	2	3	49
GTC 85-72	35	36	33	42	40	46	37	36	35	33	39	28	440
GTC 85-116	0	0	0	0	0	0	0	0	0	0	0	0	0
GTCP 85-180L	1	1	2	1	1	1	0	1	2	0	0	0	10
GTC 85-70	20	22	30	29	18	12	21	22	21	27	18	20	260
GTCP 85-397	28	18	17	21	19	20	20	17	7	33	30	27	257
GTCP 85-180	20	14	9	13	15	10	16	19	26	20	15	14	191
GTCP 85-180-7													
GTCP 85-71A	12	13	14	11	11	12	12	15	14	20	12	13	159
T41M9A	0	0	0	0	0	0	0	0	0	1	0	0	1
GTCP 85-106	1	0	1	1	0	1	1	2	3	1	0	2	13
36-50	0	0	1	0	5	2	[illegible]	0	2	1	0	1	15

Attach 5EC

AS OF FY87

ITEM DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV.	DEC	TOTAL
GTCP 165-1	0	2	3	1	0	1	0	0	0	0	1	1	9
GTC 85-56	3	3	2	2	2	1	5	6	2	4	5	3	38
GTC 85-72	18	23	27	46	22	14	0	0	0	37	30	15	232
GTC 85-116	2	0	0	0	0	0	1	0	1	0	0	2	6
GTCP 85-180L	0	1	5	0	0	1	0	0	1	1	0	0	9
GTC 85-70	16	18	15	15	16	16	18	18	18	12	9	13	98
GTCP 85-397	20	22	23	18	7	7	11	11	11	21	15	16	135
GTCP 85-180	15	14	10	13	16	17	16	17	17	16	11	13	92
GTCP 85-180-7													
GTCP 85-71A	15	15	5	8	6	5	10	10	6	16	12	15	123
T41M9A	0	3	6	2	1	3	10	7	8	1	0	1	42
GTCP 85-106	2	0	1	0	0	1	0	0	0	1	2	0	7
GTCP 36-50	1	2	1	0	0	2	0	0	0	0	0	1	7

Attach 520

AS OF FY88

ITEM DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV.	DEC
GTCP 165-1	1	1	2	0	2	2	0	3	1	2	0	0
GTC 85-56	4	4	3	5	2	4	3	3	4	0	0	4
GTC 85-72	10	18	19	16	23	26	13	12	16	3	9	16
GTC 85-116	1	0	0	1	0	0	1	0	0	0	0	1
GTCP 85-180L	2	0	0	0	0	1	1	0	0	0	1	0
GTC 85-70	11	11	12	11	11	12	7	7	6	6	6	6
GTCP 85-397	18	18	18	19	20	20	12	13	13	11	11	12
GTCP 85-180	16	16	17	21	21	21	17	18	18	15	16	16
GTCP 85-180-7												
GTCP 85-71A	8	13	13	12	12	11	12	9	12	21	10	2
T41M9A	8	6	5	6	3	1	2	0	1	6	2	5
GTCP 85-106	0	1	0	0	1	1	0	0	0	1	0	0
P 36-50	0	0	1	0	1	1	[illegible]	0	0	1	0	0

Attach. 52 E

AS OF FY-89

ITEM DESCRIPTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV.	DEC	
GTCP 165-1	1	0	~~0~~1	1	0	0	2	0	1	1	0	1	
GTC 85-56	4	4	~~1~~4	3	5	6	4	5	5	1	4	4	
GTC 85-72	12	12	~~7~~11	8	12	9	15	~~18~~ 19	15	12	11	17	
GTC 85-116	0	0	0	0	0	0	0	1	0	0	1	0	
GTCP 85-180L	0	0	~~0~~1	0	0	1	0	~~3~~ 4	5	0	0	0	
GTC 85-70	2	2	~~3~~5	5 ~~4~~	4	5	5	~~8~~ 11	6	8	8	8	
GTCP 85-397	14	14	~~14~~10	~~10~~ 18	11	11	23	~~25~~ 29	24	20	21	21	
GTCP 85-180	11	12	~~11~~7	~~6~~ 12	6	~~5~~6	7	~~7~~13	8	11	11	10	
GTCP 85-180-7			1	1									
GTCP 85-71A	11	9	10	~~9~~ 10	12	9	9	9	5	13	11	7	
T41M9A	3	3	~~2~~1	1	2	1	3	3	3	0	0	0	
GTCP 85-106	1	1	~~1~~0	0	2	0	1	1	2	0	1	0	
GTCP 36-50	1	0	~~0~~1	1	0	2	2	~~0~~2	2	0	1	1	

GTE: SOLD TO SUPPLY AS OF 20 Aug 90

[illegible]	1 1	2 2	3 3	4 6	5 7	6 8	7 9	8 10	9 13	10 14	11 15	12 16	13 17	14 20	[illegible] 21	16 22	17 23	18 24	19 27	20 28	21 29	22 30	23 31	OWO	YARD	DISSY
GTCP 165-1					5					6									7					5	0	0
GTC 85-56								35				36				37				38				5	0	0
GTC 85-72	155	156 157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	59	8	0
GTC 85-116																								0	0	0
GTCP 85-71A		80		81		82		83	84		85		86		87		88		89		90		91	15	8	1
GTCP 85-70	71		72		73		74		75		76			77		78		79		80		81		19	6	1
GTCP 85-397 +14		156		157	158	159	160	161	162	163	164	165	166		167		168		169		170		171	±185 49	5	0
GTCP 85-180	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	60	19	2
GTCP 85-180-7																5					6		7	11	1	0
GTC 85-180L NAVY													10											1	1	0
GTC 85-180L A/F											3							4						2	0	0
GTCP 85-106										6							7							5	0	0
GTCP 36-50							8							10										1	4	0
T41M9A																								3	2	0
																	TOTALS							233	54	4

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
2835-00757-2205 SEAL PN 358253	185	0	0	0	0	0	PR from 10 rec [illegible]
2835-00-908-9322 SPACER PN 693588	35	41	0	0	0	0	
2835-01-013-4806 LINER PN 899244-5 CHAMBER COMBUSTION	20	3	0	0	0	0	
2920-00-091-6352 GENERATOR PN 48044	2	0	0	0	0	0	411 ea on contract n-32

SOLD TO SUPPLY

399 - 3ea

FIGURES IN WORK

56 1ea	56-
72 2ea	72-
70 - 2ea	180L-
397 - 3ea	70-
180 - 1ea	397-
3650 2ea	180-
71 - 1	71-
71 - 1 [illegible]	T41M9A-
106 - 1ea	106-
T3360 - 2EA	3650
	180L-

REJECTS

165-1 1ea T41M9

72 - 1ea

70 - 2ea

397 - 1ea

180 - 1ea

71 - 3ea

28

```
QR2071              PRODUCTION HISTORY REVIEW      DATE:  90/08/21  10:36:27

LIST BY: * PRODUCTION-NBR:  13094A      FYQ:
         - FYQ:             883         PRODUCTION-NBR:
         - PSSD:                        PRODUCTION-NBR:

  SN     FYQ  IND-S  IND-M  CMP-S  CMP-M  GWO-S  GWO-M  COND-S COND-M EI-LAB-STD
 ------  ---  -----  -----  -----  -----  -----  -----  ------ ------ ----------
 13094A  883    50      0     38      0     33      0      0      0          .0
 13094A  884    24      0     34      0      2-     0      0      0       396.1
 13094A  891    32      0     42      0      0      0      0      0       398.6
 13094A  892    32      0     32      0      0      0      0      0       401.0
 13094A  893   102      0  [redacted] 0     32      0      0      0       411.4
 13094A  894   126      0  [redacted] 0     97      0      0      0       413.6
 13094A  901   214      0  [redacted] 0    117      0      0      0       414.6
 13094A  902    46      0  [redacted] 0    107      0      0      0       414.6
 13094A  903     0      0  [redacted] 0     64      0      0      0       411.0
                 0      0      0      0      0      0      0      0          .0
                 0      0      0      0      0      0      0      0          .0
                 0      0      0      0      0      0      0      0          .0

    F4 - LIST PROD HISTORY       F12 - CLEAR SCREEN          F16 - RETURN
    F5 - LIST NEXT PROD HST      F13 - HELP                 SF16 - LOGOFF
 QR22713: END OF SELECTED DATA HAS BEEN REACHED
```

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Attach. 59 G

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```
QR2071              PRODUCTION HISTORY REVIEW      DATE:  90/08/21  10:36:41

LIST BY: *  PRODUCTION-NBR:   13095A       FYQ:
         -  FYQ:              883          PRODUCTION-NBR:
         -  PSSD:                          PRODUCTION-NBR:

   N     FYQ  IND-S  IND-M  CMP-S  CMP-M  OWO-S  OWO-M  COND-S COND-M EI-LAB-STD
 ------  ---  -----  -----  -----  -----  -----  -----  ------ ------ ----------
 13095A  883    44      0     53      0     17      0      0      0         .0
 13095A  884    57      0     47      0     27      0      0      0      413.3
 13095A  891    20      0     34      0     11      0      0      0      406.2
 13095A  892    25      0     17      0     19      0      0      0      404.5
 13095A  893    20      0  [redacted] 0     17      0      0      0      420.7
 13095A  894    46      0  [redacted] 0     32      0      0      0      421.6
 13095A  901    30      0  [redacted] 0     44      0      0      0      419.0
 13095A  902    20      0  [redacted] 0     34      0      0      0      419.9
 13095A  903    20      0  [redacted] 0     31      0      0      0      389.2
                 0      0      0      0      0      0      0      0         .0
                 0      0      0      0      0      0      0      0         .0
                 0      0      0      0      0      0      0      0         .0

   F4 - LIST PROD HISTORY       F12 - CLEAR SCREEN          F16 - RETURN
   F5 - LIST NEXT PROD HST      F13 - HELP                 SF16 - LOGOFF
 QR22713: END OF SELECTED DATA HAS BEEN REACHED
```

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Attach. 5f H

NEGOTIATED REQUIREMENTS REVIEW RCS: U-G402A-72A PAGE 1

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PSSD: NAME: CORTINAZ J B329 RM2A PHONE: 54667

PSSD	PDN	END ITEM IDENTITY	RGC	FYQ	--INPUT REQMT-- S-GEN	M-GEN	--OUTPUT REQMT- S-GEN	M-GEN	D073 REQMT
MTPG9E	13094A	2835012422189	J	883	25	0	38	0	57
MTPG9E	13094A	2835012422189	J	884	26	0	34	0	57
MTPG9E	13094A	2835012422189	J	891	32	0	42	0	80
MTPG9E	13094A	2835012422189	J	892	32	0	32	0	251
MTPG9E	13094A	2835012422189	J	893	102	0	66	0	135
MTPG9E	13094A	2835012422189	J	894	81	0	62	0	282
MTPG9E	13094A	2835012422189	J	901	60	0	51	0	282
MTPG9E	13094A	2835012422189	J	902	46	0	46	0	69
MTPG9E	13094A	2835012422189	J	903	0	0	50	0	70
MTPG9E	13094A	2835012422189	J	904	15	0	54	0	163
MTPG9E	13094A	2835012422189	J	911	31	0	0	0	0
MTPG9E	13094A	2835012422189	J	912	47	0	61	0	61
MTPG9E	13094A	2835012422189	J	913	17	0	34	0	34
MTPG9E	13094A	2835012422189	J	914	31	0	0	0	0
MTPG9E	13094A	2835012422189	J	921	0	0	0	0	61

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Attach. 59I

PSSD: NAME: CORTINAZ J B329 RM2A PHONE: 54667 31

PSSD	PDN	END ITEM IDENTITY	RGC	FYQ	--INPUT REQMT-- S-GEN	M-GEN	--OUTPUT REQMT- S-GEN	M-GEN	D073 REQMT
TPG9E	13095A	2835012410074	J	883	44	0	57	0	44
MTPG9E	13095A	2835012410074	J	884	57	0	47	0	44
MTPG9E	13095A	2835012410074	J	891	33	0	34	0	34
MTPG9E	13095A	2835012410074	J	892	25	0	25	0	48
MTPG9E	13095A	2835012410074	J	893	32	0	22	0	143
MTPG9E	13095A	2835012410074	J	894	31	0	32	0	301
MTPG9E	13095A	2835012410074	J	901	30	0	18	0	301
MTPG9E	13095A	2835012410074	J	902	20	0	30	0	150
MTPG9E	13095A	2835012410074	J	903	20	0	34	0	40
MTPG9E	13095A	2835012410074	J	904	59	0	67	0	72
MTPG9E	13095A	2835012410074	J	911	0	0	0	0	0
MTPG9E	13095A	2835012410074	J	912	0	0	0	0	0
MTPG9E	13095A	2835012410074	J	913	0	0	0	0	0
MTPG9E	13095A	2835012410074	J	914	0	0	0	0	0
MTPG9E	13095A	2835012410074	J	921	0	0	0	0	0

Attach, 59J

ENGINEERING NOTES

EMPLOYEE P. Parker DATE 8/16/90 PAGE NO. 52

RCC GTE (all) SUBJECT Work sampling

I spoke with Danny Gonzales this A.M. Danny requested that we perform work sampling on GTE parts, as he felt that this would be the only way to obtain useable time elements. This somewhat suprised me, as we had discussed this subject several weeks ago, and I thought we had decided against it. Still, his points are valid, and we shall attempt to formulate a plan to accomplish this request. The attached memo is a discussion of my personel thoughts on the matter from a functional standpoint. While the memo is self-explanatory, I would like to stress my concern of the limited time to perform this task. I would also like to point out that the present surge conditions on several items, including the -397 eng. itself, could present some difficulties. I am confident, however, that with Danny's help we should be able to overcome these constaints. Danny has set up a meeting with Susan Schottle tomorrow AM. to further discuss this subject.

Ken Arenio and I discussed an idea that we had of a short term solution to a particular GTE production problem. Given the reported fact that there is an apparently high failure rate of GTEs in final test due to vibration problems, and it is our understanding that rotating parts processed in the system loose their mated identity, we suggest that newly inducted GTEs should have the rotating parts (wheel and shaft, etc.) "hand carried" through the system as a mated set. Since those GTEs coming from the field for scheduled overhaul have a proven track record of performance, this would appear to have some merit in reducing the vibration problem, or at least assist in isolating its cause. While there are several unclear aspects to the idea, we feel it warrants further study.

DDB SECTION CODE 8.0/9.0 DDB PAGE NO.

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MEMO

Subject: GTE work sampling considerations.

To: Pete Garza, Danny Gonzales

CC: S. Schattle, G. Gardner, D. Hayward, B. Castle, Y. Medina, R. Lozano, (other involved ALC personnel as required)

From: Phillip Parker, MDMSC

These are my initial thoughts on work sampling in the GTE repair process. I would suggest that we select those parts which have historically long flow times and/or complicated repair processes (in order to limit the study to a realistic number of components). For this reason, many of the parts which travel to various backshop operations are prime candidates. I would further suggest that the tracking of parts in MATPSI and MATPGB be restricted by the same criteria, as these areas have certain limiting factors which could adversely affect our goal in performing this analysis (i.e., production's request that we limit impact on their processes, the present surge in production of these items, etc.). The use of data elements from previous efforts in these RCCs, where applicable, should be considered. These data elements would naturally require validation by informed ALC personnel as to their accuracy, on a case by case basis.

Once the component parts to be analyzed are identified, the tracking of these items should be restricted to the flow time in and out of an RCC, as well as between the various RCCs. This should avoid the possibility of a Union grievance based on any misperception by Labor that we are auditing specific technicians, which is certainly not the case. I also feel that restricting the tracking of components to overall flow times in the various RCCs will provide data of sufficient accuracy to characterize the GTE process for modeling purposes at this time. This would not remove the need to obtain estimates of the "hands-on" labor times within an RCC. Again, any relevant data from existing studies should be used where possible. In my opinion, the labor times should be obtained from, or at least validated by, the RCC's first line supervisor. Figure One, shown on last page of this memo, illustrates these ideas.

I feel that the personnel most qualified to log these parts in and out of the various RCCs would be the schedulers/expediters, who

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are responsible for parts routing. Again, this would lower the impact to production, and would further provide a more defined accountability system for the study. It would also be necessary to identify the personnel in the parts pool who would be responsible for logging the parts in and out of this area. I would suggest that we track specific components to the the parts pool, and at the same time track like components from this area to the assembly shops. The reason for this would be the assumption that items tracked into the parts pool may reside therein longer than the length of the IPI contract. As the specific items tracked into the parts pool do exit the system, ALC personnel can begin to analyze the dwell time in this area, which I assume to be relatively long.

Functionally, I would suggest some form of visible tagging of the components to be tracked. This is an area in which I would appreciate feedback from involved personnel. I can think of several methods of identifying the components, all of which have both strengths and weaknesses. The tracking of items by specific serial number would be most accurate, but would require more time and effort on the part of the scheduler/expediter logging the item. Attaching a dated tag to the part would be relatively simple, but the tag would need to be removed for many process operations. A significant probability of lost tags exists. Attaching the tag to the item's WCD would lower this risk, but would also require more effort on the part of the scheduler/expediter. It would also invite the criticism that we are tracking only paperwork, not actual components, as we assume that WCDs can become separated from their associated parts during batch processes. (Personally, I feel that an argument could be made for this method, but I would like to hear comments from involved personnel first). Finally, the number of like parts to be tracked must be identified given the consideration that a certain percentage of tracked items will be delayed, condemned, or otherwise lost during the study. These would then be unavailable for use in constructing the simulation model files.

Risks -

- Possibility of a Labor grievance due to misperception of our intent.
- Impact on production due to additional paperwork/tagging tasks.
- Impact on scheduling/expediting functions due to additional duties.
- Possibility of data unavailability in time for model validation.
- Possibility of skewed data given high visibility of tagged items.

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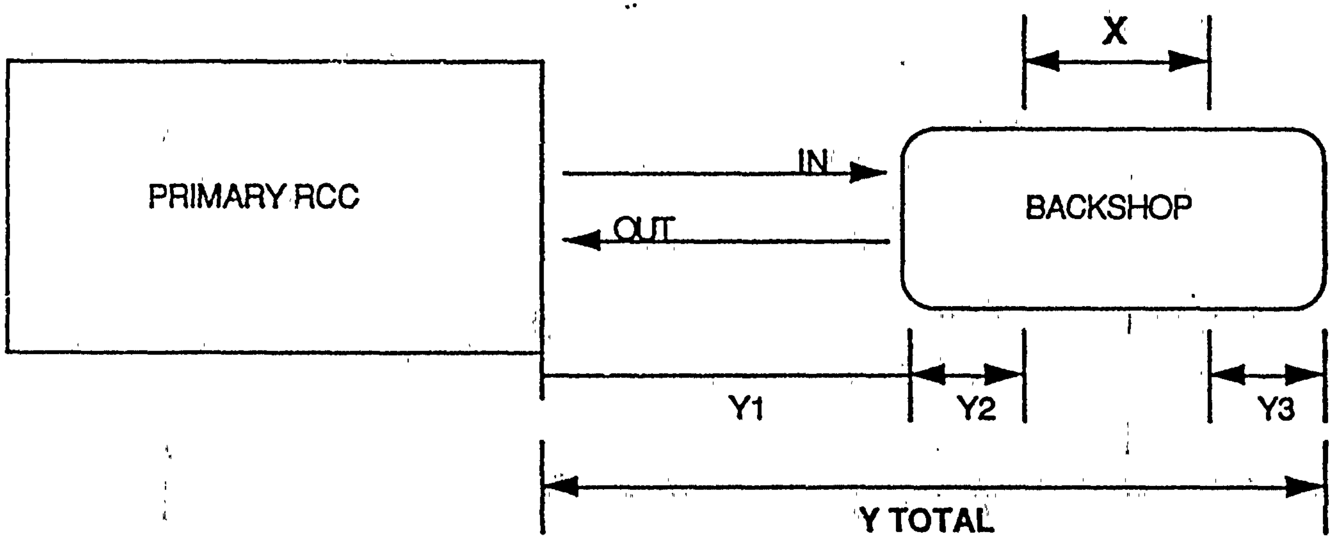

Figure One: Work sampling of flow times

The figure above is a simple schematic of the flow to and from an RCC to a backshop, and could also represent the flow from one RCC to another. We can obtain the value of **X**, which is the estimated labor time of the specific item in the backshop or RCC. This number would be obtained from the RCC supervisor (or designate), and be compared to both the planner's standard hours and the estimates obtained from the stamped WCDs. The value of **Y TOTAL** would be the cumulative times from our sample data, and would consist of the **Y1, Y2,** and **Y3** values, which represent the time in transit between RCCs, the time from delivery by scheduling to first operation, and from last operation to scheduling pick-up respectively. As a further check, this data could be compared with historic flow times from stamped WCDs. This data could be used in construction of simulation model files, as well as other analysis of GTE parts tracking and flow characteristics.

ENGINEERING NOTES

EMPLOYEE P. Parker DATE 8/17/90 PAGE NO. 56

RCC GTE 611) SUBJECT Work sampling

Greg Gardner, Ken Premo, and myself met with Danny Gonzales and Susan Schottle to discuss the idea of work sampling in the GTE area. Susan is worried about productions response at this time, as well as data being skewed due to surge conditions. I believe Danny is confident that we can still accomplish the main objectives in spite of these considerations, I think Danny has a good idea of how go about selling the idea, as well as some specific thoughts on how to implement it. We discussed some general considerations, such as how to tag the item, how to log in and out of an RCC, as well as within one, etc. I mentioned that my primary concern was one of time, as this could easily prove to be a protracted effort. We all agreed to take action items resolving the issues needed to implement the system in a rapid manner.

Basically, here are some of my ideas. I think we should have a tag on the outside of the shipping bag (or attached to the larger parts themself) for ease of material handlers logging in & out of an RCC. The tag should be a neutral color, and not be misinterpretable with RLC routing tags. An excellent idea presented by Dan Hayward for tracking times within an RCC is to structure dummy WCDs which allow start & stop times and dates to be inputted. Naturally, production's cooperation would be needed for this to work. I believe that we will need to stagger our tagging of items at different stages of the repair process if we are to obtain a sufficiently large sample size to analyze. Areas such as disassembly, MATPSI temp acclimation area, B/S induction points, parts pool outgoing distribution area, etc. are prime candidates.

DDB SECTION CODE 8.0 DDB PAGE NO.

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ENGINEERING NOTES

EMPLOYEE P Parker

DATE 8/13/90

PAGE NO. 51

RCC C-TE (All)

SUBJECT Parts list / Standards

The following attachments are listings of the component parts which make up the -397 and the -180 eng. Also shown is an example of the reporting format which I plan to present, once complete, to Mr Gonzales and associated ALC personnel to use in selecting valid model inputs. This would also be the reporting structure for subsequent data elements, including the model runs themself. For the first model run, some of the elements would be from previous process characterization efforts. The WCD data should represent flow day estimates between RCCs. Data for items processed only in MATPSI and MATPGB will be initially taken from T.O. one process characterization files, and presented for Mr. Gonzales approval.

Since Mr. Gonzales will be gone for off base training tomorrow and the next day, I am going to use this time to format and sort the labor standards for each WCD in my engine packs. This promises to be a time consuming task, and I need to start it ASAP.

8/14/90 - working standards

8/15/90 - working standards

DDB SECTION CODE 7.0

DDB PAGE NO. 360

GTCP85-180 GTE
PARTS LIST

Noun	P/N
1. **Combustion Chamber Liner**	899244-3
2. **Torus Turbine**	968959-2
3. **1st Stage Inlet Assemly**	698197-1
4. **2nd Stage Compressor Housing**	698198-
5. **Wheel and Shaft Assymbly**	3606982-1
6. **2nd Stage Diffuser Housing**	698195-1
7. Turbine Plenum	977106-1
8. Combustion Cap	695709-4
9. Flange	379692-20
10. Vent Tube	372844
11. Containment Ring	968958-2
12. Exhaust Pipe	899607-1
13. Turbine Nozzle	968886-1
14. Turbine Wheel Shroud	968233-1
15. Nozzle Bolts	968972-1
16. Nozzle Spacer	373685
17. 1st Stage Compressor Diffuser	698194-1
18. Air Duct	372696
19. Air Seal	378854-30
20. Bolt	379541
21. 2nd Stage Compressor Diffuser	892290-1
22. Oil Breather Fitting	241102
23. Bearing Housing	696659-160
24. Shroud Support	968984-1
25. Bearing Housing Flanges	969008-1
26. Oil Tube	694040
27. Oil Breather Tube	899431-1
28. Shaft Spring	379663
29. Tube Spring	74994
30. Carrier Bearing	695753-1
31. Tee	692755-10
32. Orificed Tee Assy.	692755-40
33. Impeller Retaining Nut	379523
34. Round Plain Nut	379721
35. 1st Stage Compressor Impeller	698192-4
36. Turbine Bearing Spacer	693588
37. 2nd Stage Impeller	698193-4
38. Balancing Wheel and Shaft	968095-5
Noun	**P/N**

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Attachment 51A

39.	Bearing Retainer	977895-1
40.	Planetary Carrier Assy.	378916
41.	Accessory Case Cover	977078-1
42.	Mount Plate Flange	692070
43.	Oil Pump Baffle	72906
44.	Rotating Assy. Washer	73276
45.	Fan Shaft Nut	73097
46.	Torsion Shaft	379657
47.	Accessory Drive Shaft Assy.	75285-4
48.	Main Drive Bevel Gear	73742
49.	Gear Retaining Ring	74347
50.	Generator Drive Gear Assembly	75331-4
51.	Fan Idler Gear	73849
52.	Overspeed Drive Gear	72004
53.	Spur Gear	692531
54.	Nut	75334
55.	Bearing Retainer	75969
56.	Generator Bearing Housing	371728
57.	Switch Shaft	73268
58.	Fan Shaft Spring	372080
59.	Planetary Gear Set	75282
60.	Planetary Gear Shaft	74339
61.	Planetary Gear Bushing	74340
62.	Spur Gear Assy.	371551
63.	Compressor Bearing Retainer	379485
64.	Bearing Spacer	73067-1
65.	Spacer	370344
66.	Fan Idler Gear Shaft Assy.	371856
67.	Main Shaft Seal Retainer	75333
68.	Fuel Pump Drive Shaft	3603685-3
69.	Compressor/Turbine Assy.	969197-3
70.	Final Assy. Engine	380834-1- 5 (or -1-7)
71.	Wheel/Shaft Assy.	*
72.	Balancing WCD W/S & Impeller	*

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Attachment 5/B

GTCP85-397 GTE
PARTS LIST

	NOUN	P/N
1.	Rigid Tube Assembly	694681
2.	Flexible Braided Hose	399-594-9002
3.	Planetary Carrier Assembly	378916-11
4.	Planetary Carrier Housing	75532-3
5.	Gear Assy	75283
6.	Shafts Planetary	74339
7.	Spur Gear Assy	371551
8.	Planetary Bushings	74340
9.	Preswirl Vane Housing Assy	75970
10.	Mount Plate Flange	692070
11.	Oil Cooler Fan Assy	75973
12.	Acc. Drive Shaft Assy	75285-4
13.	Gear Assy Dr.	75331-2
14.	Fan Bearing Retainer	75969
15.	Gear Ring	76389-1
16.	Overspeed Switch Shaft	73268
17.	Overspeed Switch Bushing	73267
18.	Bearing Set Spacer	73067-1
19.	Starter Barrier Guard	375652-2
20.	Starter Motor Spacer	372763
21.	Fan Idler Gear	73849
22.	Fan Idler Shaft Assy	371856-1
23.	Fan Shaft Spring	372080
24.	Bearing Retainer	73939
25.	Bearing Generator Dr. Housing	371728
26.	Bearing Retainer	75858
27.	Main Shaft Seal Retainer	75333
28.	Spur Pump Gear	692531
29.	Overspeed Switch Drive Gear	72004
30.	Main Drive Bevel Gear Assy	73742
31.	Retainer Plate	370116
32.	N.D.I. Cover Sheet (4 brg Eng)	*
33.	Combustor Cap Assy	370213
34.	Accessory Case Housing	3604090-1
35.	Diffuser Housing 1st Stage	372933-2
36.	Compresor Rotating Assembly	371690/378101
37.	2nd Stage Impeller	372556
38.	Bearing and Seal Housing	693368

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Attachment 5/C

	NOUN	P/N
39.	Interstage Air Duct	76538
40.	Torsion Shaft	371143
41.	Bearing Mount Assembly	379483
42.	Bearing Retainer	74517
43.	Retainer (2 each)	379219
44.	Spring	75675
45.	Spring Str Dr.	114877
46.	Insulator	74661
47.	Fan Idler Gear Shaft Assy	6[illegible]3522
48.	Overlay Work Control Document	*
49.	Compressor Housing	*
50.	Compressor Shaft Nut	70876
51.	Final Assembly GTCP85-397	380212-1-8
52.	Bearing Sleeve	358066-1
53.	Turbine Rotating Assy	696327-2
54.	Turbine Wheel Assy (New)	696327-2
55.	Heat Shield	75157
56.	Branched Oil Jet Nozzle	693155-100
57.	Turbine Bearing Spacer	70866
58.	Turbine Bearing Spacer	693327
59.	1st Stage Impeller Assy (Mat.set)	378101-1
60.	Oil Drain Fitting	74623-1
61.	Oil & Breather Fitting	75678-1
62.	Oil Breather Tube	376939
63.	Oil Jet Tube	693157
64.	Bearing (Turbine) Retainer	693263
65.	Elect. Comp. Maintenance	*
66.	GTE Mag. Parts Cleaning	*
67.	GTE Al. Parts Cleaning	*
68.	GTE Steel Parts Cleaning	*
69.	Assemble Planetary Gear Assy.	373444-18
70.	Accessory Case Disassembly	372896-16
71.	Accessory Case Final Assy.	375645-16

8-0

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Attachment 51D

GTCP85-180 GTE
PARTS LIST

Noun **P/N**

1. Combustion Chamber Liner 899244-3

Labor (EST) Labor STD. WCD Est. Model Output -
MATPGB: Work Sample -
MATPSI:
MATPNC:
MATPNN:
MATPNB:
MAEIAA:
MAEPDB:

2. Torus Turbine 968959-2

Labor (EST) Labor STD. WCD Est. Model Output -
MATPGB: Work Sample -
MATPSI:
MATPNC:
MATPNN:
MATPNB:
MAEIAA:
MAEPDB:

3. 1st Stage Inlet Assemly 698197-1

Labor (EST) Labor STD. WCD Est. Model Output -
MATPGB: Work Sample -
MATPSI:
MATPNC:
MATPNN:
MATPNB:
MAEIAA:
MAEPDB:

4. 2nd Stage Compressor Housing 698198-

Labor (EST) Labor STD. WCD Est. Model Output -
MATPGB: Work Sample -
MATPSI:
MATPNC:
MATPNN:
MATPNB:
MAEIAA:
MAEPDB:

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Attachment 57 E

GTCP85-397 GTE
PARTS LIST

	NOUN	**P/N**
1.	Flexible Braided Hose	399-594-9002

Labor (EST) Labor STD. WCD Est. Model Output -
Work Sample -

MATPGB:
MATPSI:
MATPNC:
MATPNN:
MATPNB:
MAEIAA:
MAEPDB:

2.	Planetary Carrier Assembly	378916-11

Labor (EST) Labor STD. WCD Est. Model Output -
Work Sample -

MATPGB:
MATPSI:
MATPNC:
MATPNN:
MATPNB:
MAEIAA:
MAEPDB:

3.	Spur Gear Assy	371551

Labor (EST) Labor STD. WCD Est. Model Output -
Work Sample -

MATPGB:
MATPSI:
MATPNC:
MATPNN:
MATPNB:
MAEIAA:
MAEPDB:

80

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Attachment 51F

ENGINEERING NOTES

EMPLOYEE P. Parker DATE 8/1/90 PAGE NO. 34
RCC GTE (-397) SUBJECT -397 GTE Eng. critical parts

I met with Brent Castle this A.M. Mr. Castle is the planner for the -397 GTE. I asked the same question that I asked Mr. Heyward; that is, what are the "critical parts" for the GTE that he is responsible for. Mr. Castle gave the following as his opinion:

	P/N
(1) Engine Turbin Nozzle	378513-4
(2) Turbine Bearing Housing	373237-200
(3) 2nd stage Diffuser Assembly	372822-7

As in the case of the -180 GTE, these parts have historically long flow times Apparently, the time required to perform repair and/or overhaul on these items is significantly longer than other sub-components that are required for GTE assembly and function.

Note the 2nd stage diffuser assy. This item is commonly known as the "short-stack", and has a complex repair process with several backshop operations necessory to its repair. This is the item which is to be repaired in the in-house machining operations which are currently being set-up. Presently, when this item is disassembled, it breaks into three major sub-components. Each of these goes through a separate repair process. The problem comes in the fact that the items are meant to be a mated set, but the parts do not return to their siblings. Apparently, the components then need extensive rework to return them to their required mated configuration. It will be necessary to collect the integral machining and processing times which are necessary to represent the new process in the model when it becomes available. The new, in-house process will keep the parts together with their siblings, thus reducing the process flow times by deleting unnecessary ops. The following is a list of all critical parts identified to date:

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RCC GTE (all) SUBJECT Critical components

CRITICAL COMPONENTS

-180

	MFG P/N
COMBUSTION LINER	899244-3/5
COMPRESSOR HOUSING	698195-
TORUS	968959-2
TURBINE WHEELS	3606982-1
1st and 2nd STAGE HOUSING (INTERSTAGE HOUSING)	968198-1 968197-1

- 397

	MFG P/N
*ENGINE TURBINE NOZZLE	378513-4
2nd STAGE DIFFUSER ASSEMBLY ("SHORT STACK")	372822-7
*TURBINE BEARING HOUSING	373237-2

* - Get bar code # from Trent and see Mary in the comp room of the APIS area for stats on [illegible] parts. Note - Susan Randolf the computer scientist in charge of the software system for this area.

Note -

(1) workloads in various RCCs for these specific parts vs. other parts? How do we determine manpower/Eq. utilization?

(2) Need: standards for each part and/or opn.
supervisor's estimates for each part and/or opn.
M.F. times for each part through an RCC
Model estimate for each part through an RCC

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ENGINEERING NOTES

EMPLOYEE P. Parker DATE 8/7/90 PAGE NO. 45

RCC GTE (all) SUBJECT Standards

As part of data to be used for comparison purposes, ~~the~~ labor standards are perhaps most easily obtained. These standards have been developed by the GTE planning pesonnel, and consist of both engineered and non-engineered time studies. While any time standard is open to discussion as to its applicability and validity, these should provide a basis for comparison of production estimates at the very least.

I discussed this briefly before, as can be seen on page 38 of my notes. Basically, we should use the labor standards and production's estimated labor times to arrive at a realistic model input value for specific operation or process times. The model operation files would require one further piece of data. The mandatory flow time between operations or processes must be collected. These can take the form of both structured and non-structured delays, transport times, etc. Structured delays can be defined as those which have been figured into the process, or are intrinsic to it. Examples of these would be the mandatory cooling time for items after heat treat or similar operations, or the delay that parts experience awaiting a predetermined lot or batch size to accumulate. Non-structured delays would take the form of items waiting in queue for various resources, or simply those times when a part dwells in the system <u>without</u> value-added processing applied to it. Much of these time elements were previously captured in both the IN and OUT operation steps of our ops. profiles, or at least the attempt was made there. In reality, a more serious effort should be made to document the exact nature of the non-structured flow times. We hope to accomplish that in our present efforts.

The following attachment, 45A, is an example of the labor standards

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RCC GTE (All) SUBJECT Standards

which I am using to build my comparitive data sheets. The source for these is the MASTER STANDARDS list; The main drawbacks that I see here is the fact that it will be time consuming to sort through these listings, and that the listings, especially in machining and plating processes, are combined in one standard. In actuality, the item may have one operation performed, route to another backshop of another opn., and <u>then</u> return for its subsequent opns. Also, I am not sure that the standards are taking into account batching considerations, especially set-up times necessary to process a specific lot size. These considerations aside, it is my opinion that the standards should be sorted and used as suggested.

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Attachment 454

```
MTPNC 7   13094A   PMC65 MATCHING OF DIFF. TO HSG.     JA     1.00   N       .75    E
MTPNC 7   13094A   PMC66 GEAR <DP,BW>      371551  207N JA    1.17   N       .19    E
MTPNC 7   13094A   PMC67 REMOVE/INSTALL 378363-2/-3    JA     1.00   N      2.00    E
MTPNC 7   13094A   PMC68 REPAIR NOZZLE/VANES 378513-4 JA       .72   E      5.97    S
MTPNC 7   13094A   PMC69 FAN SHAFT CENTERS PN 372420   JA     1.00   N      1.00    E
MTPNC 7   13094A   PMC70 CAP <LA>          370213  207E JA     .32   E       .83    S
MTPNC 7   13094A   PMC71 TORUS P/N379185-52    711N    JA     1.00   N      2.20    E
MTPNC 7   13094A   PMC72 STACK UP ASSY             207E JA     .95   E      2.11    S
MTPNC 7   13094A   PMC73 ACCY CASE  P/N 372896-16/-20 JA      1.00   N      1.25    T
MTPNC 7   13094A   PMC74 HSG <BW-DP> 372647-200   207E JA     1.71   E      1.24    T
MTPNC 7   13094A   PMC75 ACCY CASE P/N 372896-16/-20  JA      1.00   N       .50    E
MTPNC 7   13094A   PMC76 HSG <M,BW>   372647-100  207E JA      .92   E      4.08    S
MTPNC 7   13094A   PMC77 HSG,DIFF,DSWL<N MATCH    207E JA      .09   E      8.86    S
MTPNC 7   13094A   PMC78 ACCY CASE <JB> 372896-16/-20 JA      1.03   E      1.88    S
MTPNC 7   13094A   PMC79 ACCY CASE <DP> 372896-16/-20 JA       .50   N       .71    E
MTPNC 7   13094A   PMC80 TORUS <M>      379185-52  207E JA    1.32   E       .90    S
MTPNC 4   13094A   PMC81 SHAFT <LA-GD>    372420  207E JA      .88   E      2.32    S
MTPNC 7   13094A   PMC82 DUCT <BW-LP> 372696       406E JA    7.00   E       .08    S
MTPNC 7   13094A   PMC83 SHROUD <BW>    372555-5  207N JA     1.06   N       .24    E
MTPNC 7   13094A   PMC84 PIPE <BW-DA>      379196  207E JA     .87   E      1.49    S
MTPNC 7   13094A   PMC85 DIFFUSER <BW> 372933-2   207E JA      .98   E      1.84    S
MTPNC 7   13094A   PMC86 SHAFT(BW) 372420          203E JA    1.00   E       .18    S
MTPNC 4   13094A   PMC87 SHAFT F/G'D' 372420       407N JA    1.00   N      1.25    E
MTPNC 7   13094A   PMC88 FLANGE. EXT 74934-1 (BW-LA)   JA      .87   E       .54    S
MTPNC 4   13094A   PMC89 RETAINER<GD.LP> 371455   207N JA      .01   N       .38    E
MTPNC 4   13094A   PMC90 BODY <FG>        118431-1  207E JA   1.09   E       .46    S
MTPNC 4   13094A   PMC91 BODY <FG>        118431-1  207E JA   1.00   E      1.03    S
MTPNC 7   13094A   PMC92 BODY <BW-CA>     75047-9  207N JA     .24   N      1.05    S
MTPNC 7   13094A   PMC93 ARMATURE<LA>  48316-11   207E JA      .11   E      1.71    S
MTPNC 7   13094A   PMC94 CARRIER <BW>      378916  207N JA     .30   N       .75    E
MTPNC 7   13094A   PMC95 TORUS REDRILL P/N 379185-52  JA       .60   N       .36    E
MTPNC 7   13094A   PMC98 DIFF PN373823            806N  JA    1.00   N      2.00    E
MTPNC 7   13094A   PMC99  IMPLR 2ND STG. P/N 372556   JA      1.00   N      2.50    E
MEPSC 4   13094A   PME10 TURBINE WHEEL ASSY            SF     1.00   N       .40    E
MTPNM 5   13094A   PMN01 EB WELD CAP P/N370213         WL     1.00   N       .16    E
MTPNN 8   13094A   PMN02 EB WLD DFFSR PN373823         WL     1.00   N      1.11    E
MTPNN 6   13094A   PMN03 MACH COMP HSG P/N372647-100   JA     1.00   N      3.50    E
MTPNN 8   13094A   PMN20 BUSHING 1.875 OD 1.5     106N JA     1.00   N       .28    E
MTPNN 8   13094A   PMN50 TOOLING SUPPORT          109N JC     1.00   N       .37    T
MTPMC 1   13094A   PWD30 CLN,CHK,TEST SLAVE OIL TANK  YI      1.00   N       .45    E
MBPSM 6   13094A   PWE40 PRESSURE TEST HOSES           SC     1.00   N       .53    E
MBPSM 6   13094A   PWE45 MFG. AS PER SAMPLE            SC     1.00   N      1.05    E
MTPPH 8   13094A   REJ01 GTE L/VAL REJ SUPP   <V> 311N HF      .25   N      4.91    E
MTPPH 8   13094A   REJ02 REJECT SUPPORT-PUMP <H> 312N HF       .20   N      2.60    E
MTPPH 8   13094A   REJ03 REJECT SUPPORT-SW   <H>  406N HB      .25   N      2.40    E
MTPPH 8   13094A   REJ04 REJECT SUPPORT-REG. <J> 312N HB       .10   N      1.14    E
MTPPA 4   13094A   REJ16 FUEL CNTRL REJ SUPP (C)       HF     1.00   E      1.80    S
MTPPA 4   13094A   RTE01 VALVE 2D1070              310E HB    1.00   E      1.09    S
MTPPF 4   13094A   RTE02 O/H ATOMIZER 75076-18         HB     1.00   E       .63    S
MTPPA 4   13094A   RTE03 CONTROL% PUMP         <6> 303E HB    1.00   E      7.72    S
MTPPE 8   13094A   RTE06 O/H ATOMIZER 75076-18    306N HB     1.00   N       .65    S
MTPPH 8   13094A   RTI03 LD.VAL.109016-11     <V>  212E HB    1.00   E      7.44    W
MTPPH 8   13094A   RTI04 CENT SW 370929-18   <V>   602E HB    1.00   E      2.67    T
MTPPH 8   13094A   RTI05 REGULATOR 108032-3 <J>    212N HB    1.00   E      1.77    S
MTPPH 8   13094A   RTI06 OIL PUMP 371976        <H> 303E HB   1.00   E      4.25    T
MTPPH 8   13094A   RTI08 <NDI>SW. 370929-17 <J> 209E  HB     1.00   E       .43    S
MTPPH 8   13094A   RTI10 <NDI>PMP 371976-7    <H> 209E HB    1.00   E       .62    S
MTPPE 3   13094A   SFW01 SAFETY WIRE 377396-4.         HB     1.00   N       .25    E
MTPPE 3   13094A   SFW02 SFW INSP TAG SOL VALVE.       HB     1.00   N       .10    E
MTPPE 3   13094A   SFW03 SFW INSP TAG VLV FUEL DRAIN   HB     1.00   N       .10    E
```

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ENGINEERING NOTES

EMPLOYEE P. Parker DATE 8/8/90 PAGE NO. 417

RCC GTE (611) SUBJECT handling of "non-critical" items

Danny Gonzales, Ken Moreno, and I met with Yvonne Medina this morning. Basically, we discussed she and Roger Lozano's role in this program. Ms. Medina offered to assist us in the analysis of the various historical webs we will be dealing with. This was a most welcomed offer as this promises to be a tedious, if necessary, task. Ms. Medina and her coworker are also interested in being involved in the various aspects of creating and validating the simulation model in the GTE area, as well as analyzing and experimenting with the model results. To this end I have provided her and Mr. Lozano with several pages of information relating to this program. I also gave her a copy of my rough format notes from 8/6/90 which explained my basic premises on primary data collection efforts. As we begin more detailed data characterization I will provide instruction and documentation to her group as available. Naturally, Mr. Gonzales will recieve all of this information before it is distributed elsewhere, and be given the opportunity to provide guidance and instruction on any proposed methodology we have. Mr. Gonzales was kind enough to provide suggestions and help structure everyone's role in this joint effort to date. Again, I was very pleased when Mr. Shutter and his people in MATES made the offer of becoming involved.

After the meeting with Yvonne, Danny questioned us on the way in which we propose to approach the characterization of "non-critical" items (ie, items having shorter flow times than those items identified as "critical"). My main reasoning for wanting to have a layered model approach has been discussed elsewhere. Basically, the first model run should be expected to provide a framework from which Danny can guide us in what areas will require certain levels of detailed characterization. The

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ENGINEERING NOTES

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RCC GTE (ell)
SUBJECT handling of non-critical items

items which show a lower flow time than those identified as critical can initially be structured from labor standards, previous data characterization efforts in MAT/SI and MATPGB, planning/Engineering estimates, etc. Those items which move from one RCC to another might also have stamped WCD data which could be used to provide an estimate of historical flow times. There are draw backs to using this data, of course, as it is easily corrupted by certain common production practices. In reality, I feel that only the flow time between RCCs is of any value whatsoever from stamped WCDs, and this itself is a rough approximation.

In any case, once the initial model is created, an idea can be obtained as to both form and function of the next model layer, or (if necessary), a completely restructured model can be constucted. The important thing is to put some forethought into the integral data elements to be inputted, document all assumptions, validate the selected inputs, and construct the prototype model as soon as possible.

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EMPLOYEE C. Parker DATE 7/31/92 PAGE NO. 32

RCC GTE (-180 eng) SUBJECT -180 eng. critical items

I spoke with Dan Heyward today. Mr. Heyward is the planner responsible for -180 GTE. I asked him what, in his opinion, were the critical items or sub-components in the -180 GTE O/H process. The criteria I requested he use in forming his conclusion were those items having long flowtimes in the system. Mr. Heyward quite readily answered. The following are the items he felt were canidates for the "critical path" I am trying to construct:

	P/N
(1) Combustion Liner	899244-3 (or -5)
(2) compressor Housing	698195-1 (or -2, -6)
(3) Turbine Torus	968959-2 (or -15)
(4) wheel & shaft ASSY	3606982-1
(5) 1st Stage Inlet Assy	698197-1
(6) 2nd stage Compressor Housing	698198-1

Besides long flow time, Mr. Heyward further felt that these items could be considered critical due to their common unavailability in the MIC. I feel that this is to be expected since items having a long flow time would not return to the parts pool as quickly as the other component parts undergoing rework. I feel that it is reasonable to assume that these parts represent limiting factors on production, and may serve as a basis in identifying the expected flow time for the production of a single GTE, at least to some extent.

Mr. Heyward also showed me one of the metal routing tags which production uses to track parts through the system, especially in MATPSI. The now tags have a bar code strip on them. Mr. Heyward felt that there were some problems associated with these tags, such as the fact that they would need to be

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RCC GTE (-180 eng) SUBJECT Bar coding considerations

removed during certain process operations (such as cleaning, plating, etc.) which could cause a potential loss of accountability for specific parts. He also worried that the placing of the scan code on the WCD paperwork would lead to difficulties. The WCDs are often folded and placed in packing bags with the part. The system could be very user unfriendly if the individual technicians were forced to remove the WCD, unfold it, and then "wand it in". I tend to agree, and I would worry that the system would begin to be corrupted by the tracking of paperwork rather than parts if care is not used. Bar Code systems need to be easily used if they are to be effective.

It is interesting to note that bar coding was used in this area previously. Mr. Heyward suggested that I speak to a Mr. Manuel Diego for information about both the old and the new system. I would like to find out why the old system was discontinued, and how to avoid any previous problems. The use of bar coding for the new parts tracking system previously mentioned could be extremely useful, but care must be exercised in the implementation of such a system.

I have an appt. to speak with Brent Castle tomorrow morning. Mr. Castle is the planner for the -397 GTE.

Attachment .33A shows the results of a work sampling performed on the combustion liner for the -180 eng. This originated with a Mr. Roger Lozano, and was given me by Mr. Heyward. I will call Mr. Lozano tomorrow, as this is an interesting bit of data, and I wish to see if he has more data of a similar nature.

Note - There are other considerations involved in critical item identification. For example, stock outages, such as Planetary Gear bushings, can also cause delays.

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Attachment 33A

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~~Sam Feather~~
⇒ section schedule
for 303

7 JUN 90

COMBUSTION CHAMBER LINER SURVEY
SAMPLES

[illegible]

DATE IN	060390	150390	020390	150390	130490	130490	230290	310190	120989	130290	300190	310190	310190	070290	300190	AVG REPAIR DAYS
SAMPLE NO	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	
SERIAL NO	361	352	922	275	1061	1066	1110	1138	120	612	262	010	1131	1142	1130	
OPS NO																
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10																
20																
25																
32	9		4			5		2	2	1		2	2	5	2	3.4
34											1					1
36		1	1	1	5			3	5	1	1	3	3		1	2.27
38		4				8		8						1		5.25
39	1	1	1	1	2	1		2	2	1	4	1	1	1	4	1.64
40	2		1	2	4	3		1	4	4	1	1	1	1	1	2.00
45																
50		2	1		1	1		5	2		6	14	13	4	6	5.00
52		3	2		1			1	2	2	2	1	2	2	2	1.82
55		2	2	1	4			1	3		5			1	7	2.89
57	1		1		1	1	3	3	1							1.57
60	1	5	1	1			2	2			2	2	2	1	2	1.91
65																
70			3	1			1	1	2			1	1	1	1	1.33
75		1														1.00
80	2	1	2	1	3	2	1	1	5	1	1	2	2	2	2	1.87
82	19	7	21	19	6	2	3	3	2			1	1	1	1	6.62
85	1	2		1	4	8			14	3	3	1	1		1	3.55
TOT DAYS	36	29	40	28	31	31	10	33	44	13	26	29	29	20	30	28.60
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	
	120490	130490	110490	120490	140590	140590	050390	050390	260290	260290	020390	010390	010390	280270	010390	

ENGINEERING NOTES

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RCC GTE (general) SUBJECT Outline of higher order modeling

Mr. Gonzales, after discussion with Mr. Aike and others, gave the go ahead on working with Mr Lozano and Ms. Medina. I was pleased with this for two reasons: I feel that their assistance and experience within the system could prove of great value, and I think it is an extremely good idea to involve as many ALC engineers as possible in this program in order to train them in simulation technology. Everyone associated with this program has come to realize that building a functional, valid simulation model is a rigorous process. Passing on our experience and knowledge must include an active participation by the end user, not just passive acquisition of this knowledge from reading our reports and listening to briefings. Unfortunately, ALC engineers and planning personnel are in short supply, and therefor very pressed for time. For this reason, MDMSC personnel on this program need to put a great deal of forethought into how we utilize ALC personnel who offer to help us in meeting our contractural obligations. We need to always keep in mind the fact that these people will be the users of the model long after we are gone, and must understand both the functional and theoretical aspects of what we are trying to accomplish. This becomes even more important given the fact that production environments are constantly changing in the ALCs, and the end users must be prepared to change the model files to reflect future occurrences.

For these reasons, I have sketched out the following rough notes for the "layered" modeling approach we are presently using. Again, the theory here is to create a functional "superstructure" model, which is meant to provide an overview of the production process to be studied. Areas which require more detail are then grafted in as needed. By using this technique, we feel that both the quality and functionality of the model are increased. The modeler's time is more effectively utilized,

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RCC GTE (general) SUBJECT outline of higher order mod

and areas of the production process which require more detailed analysis are more likely to be recognized, as there is less chance of these becoming obscured with unneeded detail. For the same reason the chance of errors in the model files is reduced, as highly detailed inputs into the model, performed without due consideration or the overall product flow, increases the possibility of "compounding errors" which can completely invalidate the model results. The working notes follow:

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RCC GTE (General) SUBJECT Outline .....

If parts are condemned, obtain what percentage of the total this occurs. This number may be important if WIP limits are not capable of supporting production at a constant rate (i.e., may serve as a limiting factor). Of course, scrap rates are intrinsically valuable information in themself.

(D) Man power (MP) questions

The data relating to man power may be more difficult to obtain for the backshop modeling or for rough order magnitude (ROM) modeling of a primary RCC. This is due mainly to the fact that you are interested in only a portion of the area's workload. Unfortunately, the utilization of this area's resources is a dynamic quantity dependent on the entire workload. In order to avoid characterizing the area at a level of detail greater than currently desired, restrict yourself to the following questions:

- What is the total MP assigned to the shop? -
- How is this MP distributed across shifts? -
- What percent of the total workload does the item of interest represent? -
- Can the Supervisor estimate the % of MP he would assign this item? -

- Equipment constraints → This is a tough one. Are there any constraints (i.e., bottlenecks) due to equipment used in processing the specific item of interest? Why is the equip. a constraint (downtime, long process times, quantity insufficient for workload, entire workload competes with this equip, etc)? -

Some of this data may be necessary for direct input into the model, some may just be needed for background data. All, however, is necessary for a good engineering assessment.

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ENGINEERING NOTES

EMPLOYEE P.Parker DATE 8/6/92 PAGE NO. 44

RCC GTE (general) SUBJECT outline ...

(4) Remember, there are three major data entry profiles. These are :

Operation (OPS) profiles -

These contain the time and occurrences of the various operations contained in the process. In the case of backshop or high order model, this may be nothing more than a one line entry containing MP code, labor time (with associated distribution), and the occurrence factor; or even a simple mandantory flow (M.F.) time.

Resource Profiles -

These consist of both the M.P. and equipment (EQ.) records. Again, with the higher order model, these may contain data modified to meet the modeler's specific needs. Equipment, if not a constraint, may be disregarded at this level for initial evaluation of flowtimes. Note: Items which have long flowtimes may require more detailed modeling, even at this level.

Workload Profiles -

These records contain the nomenclature of the particular item to be studied, as well as the number of inductions of this item into the system. Historical and statistical analysis data are also input here.

Note ; while the ops files and the resource files may not need great detail for the first couple of model runs using this approach, the workload profiles should be fairly detailed. In my experience, it is not the quantity and detail of the data in the ops and resource files, but the quality which is the determinant for successful modeling.

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ENGINEERING NOTES

EMPLOYEE C Parker DATE 8/20/90 PAGE NO. 57
RCC GTE (all) SUBJECT work sampling

I spoke with Susan Randolph about the status of the historical documentation of the two -397 parts we are interested in. Apparently, this is a very time intensive effort. Susan has to monitor the loading of the stats, and must frequently interrupt the loading because of other system demands. She will continue on with this effort, and has promised me printouts of the <u>entire</u> WCDs (those listing every possible repair) tomorrow.

I spoke with Danny Gonzales this A.M. concerning the issue of work sampling. I stressed our need to begin this as soon as possible. He agreed, and was already in the process of contacting the appropriate ALC personnel to coordinate this effort. He is still in the process of selling his management on the idea, and must then gain both production's and scheduling's approval. I showed him a copy of the log sheet which Mr. Gardner produced for use by material handlers. Basically, this log sheet would allow them to sign in the date and time when a part is delivered to an RCC, as well as when it was picked up. Mr. Gonzales approved of this format, and we sent the master copy to the St. Louis office to have an appropriate number of these tags printed. I expect to have the first batch of these delivered next week.

Dan Heyward's suggestion about using a specially structured "dummy" WCD is meeting some resistance. There are several concerns about using this document. There is worry that production personnel may feel it is an attempt to audit individual workers, that it would be disruptive to the normal production process, and that there exists a significant chance that the forms would not be correctly filled out. I do not have any opinion in these matters, as I have never tried to implement such a thing in an ALC environment before. At this time, we are considering a log book for the floor supervisor to use, when the part is actually given to the

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ENGINEERING NOTES

EMPLOYEE P Parker DATE 8/26/90 PAGE NO. 58

RCC GTE (all) SUBJECT Work Sampling

individual technician, the supervisor would sign the part in. when the technician finishes working the part, the supervisor would sign the part out. All of this is purely speculation at this time, but it would be one way to obtain an idea of the actual time required to process an item. I think it would be a good idea for the supervisors to do this without the floor personnel's knowledge, as a more accurate idea of actual "as-is" process times would be gathered. I am sure, however, that there will be objections to this.

As stated in previous pages of these notes, I had hoped to have my first model run by this date. Unfortunately, given the change in plans that the work sampling represents, I am going to have to delay this for the time being. Mr Gonzales has mentioned that he would rather not have us perform interviews and work sampling. I understand this, as he does not want to overload production, nor does he want previous efforts to color the work sampling efforts, but I am concerned that we must not slip schedule to much at this stage.

DDB SECTION CODE 8.0 DDB PAGE NO.

ENGINEERING NOTES

EMPLOYEE P. Parker DATE 8/21/90 PAGE NO. 59

RCC GTE (all) SUBJECT Inductions

I obtained a listing of the number of -180 and -397 GTEs inducted into the system over the last few years. These are in the form of work sheets, and were given to me by Mr. Zurita, who is the scheduling supervisor. These sheets follow, and are listed as attachments 59A thru 59F. Note attachment number 59F. This sheet shows the number of items <u>sold</u> in FY 90 to date. The information contained in these sheets are summarized for the -180 and -397 engines in attachments 59G and 59H respectively. The data shown here is in agreement with the that shown on the G019C report, which is to be expected.

The last two attachments, 59I and 59J, are copies of the negotiated requirements. These were provided by Don Heyward. I am not quite sure how to interpret these sheets, and how they relate to <u>actual</u> inductions. As this seems to be a very important point, however, I will try and contact the appropriate personnel to discuss this data. As soon as I collect all of the relevant information, I will attempt to construct the model Item profiles. It will be necessary to question Danny Gonzales as to how these should be formatted, as raw data inputs may not allow modelling of the appropriate production conditions. We may have to run the model with several different input configurations for Mr. Gonzales to determine the correct format.

I also obtained WCAs for both the Turbine Bearing Housing and the Turbine Nozzle for the -397 Engine from Susan Randolph today. These reflect all possible repairs, and will require the O.F. from the stats collected from APIS operations, which are still running.

DDB SECTION CODE 8.0 DDB PAGE NO.

ENGINEERING NOTES

10

EMPLOYEE Parker
DATE 7/23/90
PAGE NO. 24
RCC GTE (general)
SUBJECT Appt.

7/23/90 - Monday

I have made appointments with Ms. Guzeman and Mr. Pike for tomorrow morning. I wish to discuss manpower availability and overtime questions with Ms. Guzeman. I would like to speak with Mr. Pike about information I will need from certain GTE planners, for whom he is the manager, as well as the various engineering functions which he oversees. I would also like him to suggest a point of contact for certain information which we received with the original T.O. 15 SOW, which showed both operations descriptions and associated times, as well as the RCCs involved. This data could be potentially very valuable to us. I would also like to question him in regard to various data bases which may reside in his area, and the appropriate managers to contact in regard to these.

DDB SECTION CODE 8.0
DDB PAGE NO.

11

ENGINEERING NOTES

EMPLOYEE P Parker DATE 7/24/90 PAGE NO. 25

RCC GTE (All) SUBJECT meetings

7/24/90 - Tuesday

Ken Premo and I met with Mr. Pike this morning. Also present was Juan Garza, who is the planning chief under Mr. Pike. We discussed several topics, including our mutual desire to reduce impact on the production capacity of the GTE area by reducing the amount of interviews and their length, especially in those areas previously characterized. Mr. Pike identified his office as the end user of the model once we are complete. I questioned Mr. Pike about what his expectations and needs for a simulation model would be. Basically, his concept of a useable model would be one which allowed analysis of those parts which have historically caused delays or other process problems, such as quality or functional impairment to the GTEs themselves. These parts should be given special attention, as they would most likely be on the "critical path" for the GTE process. I was pleased to hear this opinion, as it fits in nicely with our concept of higher order modeling. I feel that this should make efforts much more effective than if we were driven to performing our characterization at the lowest level of detail possible.

Mr. Harris, Mr. Premo, and myself also spoke with Ms. Guzeman this morning. Ms. Guzeman provided us with information on labor hours, including overtime, for several of the RCCs involved in the GTE task order. From this data I should be able to determine the manpower availability for the various areas we will be studying. An example sheet is included as an attachment to these notes, designated with today's date.

DDB SECTION CODE 8.0 DDB PAGE NO.

Some general notes on the "new and improved model" - 387

1) I went in to the historical flowday vs simulated flowing analysis with an axe. Mr. Vroman showed me how a surgeon would do it.

(A) The latest model run has O.F. built into the ops files. These are based on the observed occurrence, by operation, in the historical database.

This should have the effect of making the model flowtimes more reprentative of the historical flowtimes. I expect these to match up more reasonably, and have the added bonus of representing a model having much higher data fidelity.

(B) The historical data inputs have been thouroghly screened, and the data is more intrinsically accurate. Reference the spreadsheets and associated notes for the details of the data analysis. Also note: the historical data being analyzed here represent a larger sample size.

(C) In our detailed analysis of the historically documented data, we noticed that our data input personnel had found many cases where the data did not fit the origonal input format. We observed that the planers had provided us with the updated WCD paperwork created in 1990 (which was used in constructing the previous model runs' ops files). However, most of the historical documentation has earlier release dates than 1990 (mostly 1988). we updated our input formats and the model ops file to configure to the historical documentation. This is by far the greatest sample source, and there is question as to the accuracy of the current WCD's. applicability to the AS-IS process (Re: several complaints expressed by the shop supervision, most strongly Mr. Rodriguez, Mr Hnostrosa).

we do not feel that these changes in any way degrade the fidelity of the ops file for our model run (In fact, I think we have went from a Buick to a Porsche)[1]

(2) The parts files have been changed to reflect the more accurate average historical flowtimes, as well as show 100% occurrence for all WCDs in the backshop. This is due to the fact that we have accounted for all occurrences within the ops files. This allows for more accuracy in inputting future changes, which may be at the operational level, not the overall.

(3) About Experimentation –

I still maintain that we will need to use either log book data or interview data (decide on a case-by-case basis) for experimentation. This is due to the "artificial" nature of the ALC standards to some extent, but more to the fact that we are going to have to make some assumptions as to how things will work when the process is under control.

~~→ i.e., these flowtimes have got to come down, both in the process and in the model before any meaningful changes can be implemented in the process! ←~~

---

[1] Note – the changes I am talking about are affecting only the critical backshop actions. There is still the need for some subjectivity in making decisions as to how to combine ops both within and across RCCs when the actual sequence is not as shown on the WCDs (in any version). This goes to show that simulation is as much an art as a science.

(4) Please Note: In order to give even greater detail to the integral operations, Mr. Vromen had me subtract an average of 15 hours from the Out time on each opn. This will be explained in detail during validation

ENGINEERING NOTES

EMPLOYEE P. Po[illegible] DATE 10/10 PAGE NO. 114

RCC ALL SUBJECT Validation model

10/10/90 -

Our first validation meeting began today at 8:00 AM. Susan Schattle and Danny Gonzales represented the ALC, and Ken Premo, Scott Vroman, Greg Gardner, and myself were present for MDMSC. I spoke for a few minutes about how the ops file were formed, and about the integral information that was contained therein. I also had handouts which showed this information for comparative purposes. The information was presented as ALC Standards, Interview results, and historically documented flowtimes. This data was also accompanied by histograms which displayed the historic data in an easily interpretable graphic format. These handouts follow.

The meeting went well, and the major issue surrounded the concern expressed by Ms. Schattle that the inclusion of the large, historically seen flow times in the model would make experimentation difficult. This is due to the tendency for these large flowtimes to make the model insensitive to any changes in the much smaller integral operation times. I agree, but as Mr. Gonzales pointed out, it did represent the As-Is condition. As there were no more specific questions, Mr. Gonzales agreed to examine the runs in detail and to discuss the model in detail on Friday.

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ENGINEERING NOTES

EMPLOYEE P. Parker DATE 10/12 PAGE NO. 115

RCC ALL SUBJECT Parts Tracking

10/12/90 -

I met with Mr. Gonzales this morning to discuss the model output. He had not had time to examine the output in detail. We agreed to meet again Monday morning. We did discuss the output in general, and he instructed me to make begin formatting the rework data, which we will discuss in detail on Monday.

Ken and I spent the rest of the day in the parts tracking effort, including the formatting of this information.

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ENGINEERING NOTES

EMPLOYEE P Parkin DATE 10/15 PAGE NO. 116

RCC ALL SUBJECT Model

10/15/90 -

Ken Premo and I met with Danny Gonzales this morning to answer questions regarding the last model run. We discussed several points of interest to Mr. Gonzales. After our discussion, Mr. Gonzales' only request was that we input the Historical Flowtime Hours into the model Parts File, which will then be printed out on subsequent model runs. The historical hours will be taken from the analysis previously performed on stamped WCD data. This data is identical to that which was inputted as mandatory flowtimes into the ops file for the 1st model run, which was used only to examine the overall flowtimes of the various backshop items.

The second part of todays meeting was initiated by the MDMSC personnel. As was previously mentioned, the 3rd. model run, which was presented in the first validation meeting, did not contain rework data. This was due to the fact that we wish to see the effect on the GTE process both before and after the use of rework data. Since Mr. Gonzales did not express any particular reservations about the present form of the model (3rd cut), we are ready to proceed to the next logical step, which is the inputting of the rework data into the model ops file. We presented the rework data we have collected in its raw form to Mr. Gonzales.

The data actually consists of two individual types. The first part of the data consists of estimates of the amount of time dedicated to the rework of rejected items at the final assembly level. The GTEs which fail final test are returned to final assembly for rework if they cannot be repaired at the test cell. The data was obtained from estimates provided by both the final assembly technicians and their first line supervisors. This data is what I would consider "soft" data, as their are no existing historical documentation to substantiate it. This data does have the singular advantage of being the <u>only</u> estimate of this particular feature of the repair process, however. MDMSC site personnel would

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ENGINEERING NOTES

EMPLOYEE P. Parker DATE 10/15 PAGE NO. 117

RCC ALL SUBJECT Model

recommend that data pertaining to rework be collected very concisely at all stages of the repair cycle in future endeavors. As shop personnel tend to keep logs of failed items (at least for individual components, see attached example), the collection of time spent in repair of rejected items would not appear to present significant difficulties.

The second part of the rework data is, in my opinion, more important. This data involves the amount of time invested in both test cell utilization and actual computer run time for rejected GTEs. The data is taken from a database which is automatically maintained for all GTEs being placed on the test cells (see attached example). This data is more "hard", in that there is less guess work or supposition in its reporting or interpretation.

Both types of data was presented to Mr. Gonzales. We discussed my ideas for inputting this data, and the form I suggest we use. Mr. Gonzales concurred, and I will proceed with the structuring of this data.

Several of the calculations and much of the formatting of the rework data was performed by Mr. Premo. Further questions referring to this data should be addressed to his engineering notes for details.

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ENGINEERING NOTES

EMPLOYEE P. Parker DATE 10/16 PAGE NO. 118

RCC All SUBJECT Rework data

10/16/90 -

I spent part of today structuring and inputting the changes regarding rework data into the model. The rework data is similar in form for both the -180 and the -397 engines, but the integral times are different. The WCDs used to create the rework data are placed in the model at an occurrence factor of 24% each. This was taken from the rejects which were documented in the automated database previously described. This failure rate is of an overall amount, and is in keeping with our analysis of previous years failure rates of complete items. For more information on this subject, please refer to Mr. Premo's engineering notes.

The final form of the reject data as it appears in the model ops file is as follows:

```
* *
**********************************************************
* *
OD REWORK180        RWK180  0000 IN   P       1.00 MATPGB
BS                1C  24.00
OD REWORK180        RWK180  0010 INSP P       1.00 MATPGB
MP    BE09          1C   0.72
OD REWORK180        RWK180  0020 DIS  P       1.00 MATPGB
MP    BK10          1C   2.72
OD REWORK180        RWK180  0030 INSP P       1.00 MATPGB
MP    BE09          1N  21.08  2.86
OD REWORK180        RWK180  0040 INST S       1.00 MATPGB
MP    BK10          1C   2.72
EQ    F-25         1C   2.72
OD REWORK180        RWK180  0050 TEST P       1.00 MATPGB
MP    BK10          1T   2.72  5.44  6.80
EQ    F-25          1T   2.72  5.44  35.36
OD REWORK180        RWK180  0060 DIS  P       1.00 MATPGB
MP    BK10          1C   2.72
EQ    F-25         1C   2.72
OD REWORK180        RWK180  9999 TEST P       1.00 MATPGB
BS                1C   2.00
```

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ENGINEERING NOTES

EMPLOYEE Phillip Parker DATE 10/22/90 PAGE NO. 124

RCC All SUBJECT Validation

10/22/90 -

Scott Vroman, Ken Premo, and I met with Danny Gonzales this morning to discuss the latest model run. Mr. Gonzales had examined the run over the weekend, and had two minor errors identified in the ops files. These consisted of an incorrect RCC designator in the first backshop operation for the -397 Accessory Case Housing (incorrectly identified as MATPSI when it should have been MATPNC), and an incorrect entry for a machining operation in the -180 Bearing Housing (which probably resulted from a cut and paste error). These were notated, and will be corrected immediately.

The only other point of discussion concerned the relationship of the historical flow times to the simulated flow times. In several cases (see model output, cut 4) the difference was greater than 15%, which is a rough analysis parameter we have found useful in past model validations. There are several reasons for the observed differences. The major reason for the difference is that the data inputs which were used for historical flow times are those which were used several weeks ago in constructing the first model run, but the integral data inputs used in the ops files' IN TIME blocks were from much more recent historical data analysis. This data represents a much larger sample of the population, and in some cases varies significantly from the original data inputs. Another source of error lies in the fact that I made several assumptions in constructing the data in the ops file based on the fact that certain backshop operations exist in the ALC provided WCD operation sequence, but the historical data which we analyzed shows the occurrence of the operation very rarely. The present ALC paperwork is of a newer release than that found in the historical documentation, and some differences are present in the sequence of operation events. In several cases, I inputted operation times seen in similar backshop processes to "fill in these blanks". This in itself could have introduced some variance. Still, it is the results of the updated data inputs to the ops files, which are then being compared

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ENGINEERING NOTES

EMPLOYEE Parker DATE 10/22/90 PAGE NO. 125

RCC All SUBJECT Validation

to the outdated input data in the historical flow report, which causes the most significant differences.

After we discussed the above points of interest, Mr. Gonzales requested that I make a detailed analysis of the historical vs. simulated flow times, with explanation for each case of variance. This is an excellent request, and I will begin this immediately after making my parts tracking rounds today.

DDB SECTION CODE ________ DDB PAGE NO. ________

```
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6      PAGE:     1
------------------------------------------------------------------------------------------------------------
RUN PARAMETERS
--------------
 UDOS     :
This job was run on SAALC - 780 VAX at San Antonio.

 ALC:  SA

 RCC:  MATPGB

 REPORT ID:  CUT 6

         GTE LINE - VALID MODEL

 PART FILE:  GTE5PART.DAT
 RES  FILE:  GTE5RES.DAT
 OPER FILE:  GTE6OPS.DAT
 ETC  FILE:  GTE5ETC.DAT

 WEEKENDS = Y

 NUMBER OF QUARTERS =             4

 WARM UP PERIOD; STATS WILL BE CLEARED AT DAY         364

 # OF HOLIDAYS                     0

 HISTORICAL DATA SHIFT FACTOR   8.000000

 BACKSHOP DATA SHIFT FACTOR     24.00000

 NEW DATA FORMATS SELECTED


SIMULATION CPU TIME:      17.13 MINUTES
SIMULATION LAPSE TIME:   717.28 MINUTES

SIMULATION RUN LENGTH: 17472.00 HOURS
```

VALIDATED
BASE LINE
MODEL

```
Number of Items       :      21
Number of Resources   :      32
Number of WCDs        :      25
Number of Operations  :     437
Operations completed  :   45157
ALC:  SA  RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:    2
-----------------------------------------------------------------------------------------------------
 ITEM INDUCTIONS
 ---------------
                                             1ST QTR  2ND QTR  3RD QTR  4TH QTR      YTD
                                             -------  -------  -------  -------  -------
INDUCTIONS OF ITEM 1ST.STG.COMPR.DIFF:            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM 1ST.STG.INLETASSY.:            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM 2ND.STG.COMPR.DIFF:            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM 2ND.STG.DIFF.ASSY :            43       47       42        2      134    (MISTR)
INDUCTIONS OF ITEM 2ND.STG.DIFF.HSG. :            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM 2NDSTG.COMPR.HSG. :            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM ACCESSORY CASE    :            43       47       42        2      134    (MISTR)
INDUCTIONS OF ITEM BACKSHOP 180      :            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM BACKSHOP 397      :            43       47       42        2      134    (MISTR)
INDUCTIONS OF ITEM BEARING HSG.      :            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM COMB. CHAMBER LNG.:            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM COMPRESSOR INLET  :            43       47       42        2      134    (MISTR)
INDUCTIONS OF ITEM GTE -180          :            18       30       21        4       73    (MISTR)
INDUCTIONS OF ITEM GTE -397          :            46       46       42        0      134    (MISTR)
INDUCTIONS OF ITEM MATPSI 180 ONLY   :            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM MATPSI 397 ONLY   :            43       47       42        2      134    (MISTR)
INDUCTIONS OF ITEM TORUS TURBINE     :            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM TURBINE BRG. HSG. :            43       47       42        2      134    (MISTR)
INDUCTIONS OF ITEM TURBINE NOZZLE 180:            17       29       23        4       73    (MISTR)
INDUCTIONS OF ITEM TURBINE NOZZLE 397:            43       47       42        2      134    (MISTR)
INDUCTIONS OF ITEM WHEEL&SHAFTASSY.  :            17       29       23        4       73    (MISTR)
----------------------------------------------------------------------------------------
TOTAL ITEM INDUCTIONS                :           569      753      633       66     2021

ALC:  SA  RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:    3
-----------------------------------------------------------------------------------------------------
 WCD INDUCTIONS
 --------------
                                             1ST QTR  2ND QTR  3RD QTR  4TH QTR      YTD
                                             -------  -------  -------  -------  -------
```

```
INDUCTIONS OF WCD         TG624D  :     17       29       23       4     73
INDUCTIONS OF WCD         TG623D  :     17       29       23       4     73
INDUCTIONS OF WCD         TG629D  :     17       29       23       4     73
INDUCTIONS OF WCD         TA813F  :     43       47       42       2    134
INDUCTIONS OF WCD         TG628D  :     17       29       23       4     73
INDUCTIONS OF WCD         TG622D  :     17       29       23       4     73
INDUCTIONS OF WCD         TA537F  :     43       47       42       2    134
INDUCTIONS OF WCD         BS180   :     17       29       23       4     73
INDUCTIONS OF WCD         BS397   :     43       47       42       2    134
INDUCTIONS OF WCD         TG631D  :     17       29       23       4     73
INDUCTIONS OF WCD         TG611D  :     17       29       23       4     73
INDUCTIONS OF WCD         TG816F  :     43       47       42       2    134
INDUCTIONS OF WCD         13095A  :     18       30       21       4     73
INDUCTIONS OF WCD         RWK180  :      2        4       10       4     20
INDUCTIONS OF WCD         13094A  :     46       46       42       0    134
INDUCTIONS OF WCD         RWK397  :      6        6       12       7     31
INDUCTIONS OF WCD         CLEAN   :     17       29       23       4     73
INDUCTIONS OF WCD         INSPECT :     16       29       23       6     74
INDUCTIONS OF WCD         CLEAN   :     43       47       42       2    134
INDUCTIONS OF WCD         INSPECT :     40       45       38      11    134
INDUCTIONS OF WCD         TG615D  :     17       29       23       4     73
INDUCTIONS OF WCD         TG847F  :     43       47       42       2    134
INDUCTIONS OF WCD         TG618D  :     17       29       23       4     73
INDUCTIONS OF WCD         TA841F  :     43       47       42       2    134
INDUCTIONS OF WCD         TG645D  :     17       29       23       4     73

-----------------------------------------------------------------------------
TOTAL WCD INDUCTIONS              :    633      837      716      94   2280

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:    4
----------------------------------------------------------------------------------------------------
FLOW CYCLE TIME STATISTICS
--------------------------

                                  AVERAGE               SIMULATED  SIMULATED
                  HISTORICAL    SIMULATED               MINIMUM    MAXIMUM     NUMBER      NUMBER
                  FLOWTIME      FLOW TIME   STANDARD    FLOW TIME  FLOW TIME     OF          OF
ITEM              HOURS          HOURS      DEVIATION    HOURS      HOURS      SAMPLES   INDUCTIONS
----------------  ----------    -------     ---------    -------    -------    -------   ----------

1ST.STG.COMPR.DIFF   969.60      912.19      444.51      148.75    2326.89  [illegible]        73
1ST.STG.INLETASSY.  1536.00     1429.27      812.19      247.72    3908.94       72            73
```

```
2ND STG.COMPR.DIFF     1795.20    1851.15    1260.46      55.29    6505.88       78       73
2ND.STG.DIFF.ASSY      3240.00    3263.[illegible]    1206.28    1055.07    8102.52      128      134
2ND.STG.DIFF.HSG.      2059.20    2255.90    1591.77     147.07    6719.58       75       73
2NDSTG.COMPR.HSG.      2289.60    2157.27    1135.17     717.35    7006.84       72       73
ACCESSORY CASE          427.44     416.20     203.72      72.99    1126.71      134      134
BACKSHOP 180           1200.00    1189.18     434.81     340.11    2290.73       75       73
BACKSHOP 397            720.00     704.04     620.68      15.61    3152.39      132      134
BEARING HSG.           2714.40    2943.39    2137.77     528.75   12934.91       79       73
COMB. CHAMBER LNG.      686.88     730.46     160.34     479.82    1285.89       75       73
COMPRESSOR INLET       1644.00    1584.77    1190.96     172.39    7576.68      132      134
GTE -180                  0.00    3192.32     522.34    2574.26    5383.32       75       73
GTE -397                  0.00    3529.08     345.08    2742.82    4855.64      125      134
MATPSI 180 ONLY           0.00     736.97     144.91     416.57    1055.09       76       73
MATPSI 397 ONLY           0.00     789.65     152.26     441.03    1176.95      134      134
TORUS TURBINE           984.00    1100.19     358.38     487.88    2646.04       74       73
TURBINE BRG. HSG.      2496.00    2100.99    1531.92       9.59    7737.36      126      134
TURBINE NOZZLE 180     1768.80    1704.35    1132.01     121.00    6158.77       76       73
TURBINE NOZZLE 397     1896.00    2111.01    2062.86      22.73   11126.59      123      134
WHEEL&SHAFTASSY.       1617.60    1895.23     852.35     511.76    4864.08       74       73

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:    5
------------------------------------------------------------------------------------------------------
DIRECT LABOR STATISTICS
-----------------------

                                                SIMULATED                  SIMULATED    SIMULATED
                                                 AVERAGE                    MINIMUM      MAXIMUM     NUMBER
                         EXPECTED  STANDARD       LABOR      STANDARD        LABOR        LABOR        OF
 ITEM                      HOURS     HOURS        HOURS      DEVIATION       HOURS        HOURS      SAMPLES
------------------       --------  --------      -------     ---------      -------      -------     -------

1ST.STG.COMPR.DIFF          0.63      9.70         0.62         0.15          0.18         0.77         73
1ST.STG.INLETASSY.          2.86     15.36         2.78         0.93          0.42         5.18         72
2ND.STG.COMPR.DIFF          0.94     17.95         1.00         0.53          0.21         2.29         78
2ND.STG.DIFF.ASSY           5.98     32.40         6.06         0.57          3.95         6.66        128
2ND.STG.DIFF.HSG.           1.53     20.59         1.44         0.73          0.22         2.98         75
2NDSTG.COMPR.HSG.           3.48     22.90         3.50         0.73          1.45         4.15         72
ACCESSORY CASE              1.93      4.27         1.98         1.15          0.00         4.59        134
BACKSHOP 180                0.00     12.00         0.00         0.00          0.00         0.00         75
BACKSHOP 397                0.00      7.20         0.00         0.00          0.00         0.00        132
BEARING HSG.                4.06     27.14         4.24         1.44          1.97         9.32         79
COMB. CHAMBER LNG.          3.77      6.87         3.90         0.71          2.30         5.26         75
```

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COMPRESSOR INLET              0.90     16.44          0.89         0.33         0.21         1.91        132
GTE -180                     58.73      0.00         32.69        15.47        22.22        66.67         75
GTE -397                     58.26      0.00         31.53        14.57        21.96        63.72        125
MATPSI 180 ONLY              83.38      0.00         87.32        18.93        52.41       133.81         76
MATPSI 397 ONLY              83.38      0.00         94.46        22.12        51.83       146.26        134
TORUS TURBINE                 7.37      9.84          7.51         2.43         1.38        12.50         74
TURBINE BRG. HSG.             1.33     24.96          1.30         0.93         0.00         3.82        126
TURBINE NOZZLE 180            2.03     17.69          2.07         0.89         0.00         2.61         76
TURBINE NOZZLE 397            5.00     18.96          4.77         3.63         0.00        10.52        123
WHEEL&SHAFTASSY.              4.27     16.17          4.28         0.75         2.27         4.85         74

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:    6
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BACKSHOP DWELL SUMMARY
----------------------

                       AVERAGE              SIMULATED  SIMULATED
                     SIMULATED               MINIMUM    MAXIMUM   NUMBER
                      BACKSHOP   STANDARD   BACKSHOP   BACKSHOP   OF
 ITEM                    HOURS  DEVIATION      HOURS      HOURS   SAMPLES
------------------    --------  ---------  ---------    -------   -------

1ST.STG.COMPR.DIFF      863.55     445.67     126.31    2287.03        73
1ST.STG.INLETASSY.     1361.09     813.89     169.44    3812.19        72
2ND.STG.COMPR.DIFF     1803.98    1257.66      54.55    6408.65        78
2ND.STG.DIFF.ASSY      3087.74    1214.05     859.19    8034.13       128
2ND.STG.DIFF.HSG.      2193.24    1592.65     143.44    6693.48        75
2NDSTG.COMPR.HSG.      2067.80    1128.54     637.31    6862.21        72
ACCESSORY CASE          368.82     198.08      43.13    1102.46       134
BACKSHOP 180              0.00       0.00       0.00       0.00        75
BACKSHOP 397              0.00       0.00       0.00       0.00       132
BEARING HSG.           2828.30    2134.62     496.55   12776.80        79
COMB. CHAMBER LNG.      576.07     162.63     337.52    1192.57        75
COMPRESSOR INLET       1544.82    1194.10     154.62    7537.52       132
GTE -180                  6.93      11.58       0.00      26.00        75
GTE -397                  6.24      11.15       0.00      26.00       125
MATPSI 180 ONLY           0.00       0.00       0.00       0.00        76
MATPSI 397 ONLY           0.00       0.00       0.00       0.00       134
TORUS TURBINE           969.50     358.89     399.88    2510.81        74
TURBINE BRG. HSG.      2068.23    1532.66       6.77    7737.18       126
TURBINE NOZZLE 180     1662.56    1129.25     114.31    6139.78        76
TURBINE NOZZLE 397     2066.88    2055.46       0.00   11051.59       123
```

104

654

407

655

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WHEEL&SHAFTASSY.        1781.10     848.54      363.25    4699.88         74

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:   31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:      7
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PROCESS TIMES SUMMARY
---------------------

                     HISTOR.   SIMULATED   WAITING FOR                                          NUMBER
                      FLOW        FLOW     RESOURCES        PROCESSING FLOW     BACKSHOP          OF
 ITEM                HOURS       HOURS     HOURS     %      HOURS     %       HOURS     %      SAMPLES
----------------    -------   ---------    ------  ----     -----   ----      -----   -----    -------

1ST.STG.COMPR.DIFF    969.6       912.2      47.5   5.2%       1.1   0.1%     863.6   94.7%         73
1ST.STG.INLETASSY.   1536.0      1429.3      60.7   4.2%       7.5   0.5%    1361.1   95.2%         72
2ND.STG.COMPR.DIFF   1795.2      1851.2      45.2   2.4%       1.9   0.1%    1804.0   97.5%         78
2ND.STG.DIFF.ASSY    3240.0      3263.1     162.5   5.0%      12.9   0.4%    3087.7   94.6%        128
2ND.STG.DIFF.HSG.    2059.2      2255.9      55.8   2.5%       6.8   0.3%    2193.2   97.2%         75
2NDSTG.COMPR.HSG.    2289.6      2157.3      84.9   3.9%       4.5   0.2%    2067.8   95.9%         72
ACCESSORY CASE        427.4       416.2      42.3  10.2%       5.1   1.2%     368.8   88.6%        134
BACKSHOP 180         1200.0      1189.2       0.0   0.0%    1189.2 100.0%       0.0    0.0%         75
BACKSHOP 397          720.0       704.0       0.0   0.0%     704.0 100.0%       0.0    0.0%        132
BEARING HSG.         2714.4      2943.4     104.8   3.6%      10.3   0.4%    2828.3   96.1%         79
COMB. CHAMBER LNG.    686.9       730.5     142.9  19.6%      11.5   1.6%     576.1   78.9%         75
COMPRESSOR INLET     1644.0      1584.8      38.9   2.5%       1.0   0.1%    1544.8   97.5%        132
GTE -180                0.0      3192.3    2973.2  93.1%     212.2   6.6%       6.9    0.2%         75
GTE -397                0.0      3529.1    3320.0  94.1%     202.9   5.7%       6.2    0.2%        125
MATPSI 180 ONLY         0.0       737.0      55.4   7.5%     681.6  92.5%       0.0    0.0%         76
MATPSI 397 ONLY         0.0       789.6      53.6   6.8%     736.0  93.2%       0.0    0.0%        134
TORUS TURBINE         984.0      1100.2     116.6  10.6%      14.1   1.3%     969.5   88.1%         74
TURBINE BRG. HSG.    2496.0      2101.0      30.3   1.4%       2.4   0.1%    2068.2   98.4%        126
TURBINE NOZZLE 180   1768.8      1704.3      37.4   2.2%       4.4   0.3%    1662.6   97.5%         76
TURBINE NOZZLE 397   1896.0      2111.0      23.0   1.1%      21.1   1.0%    2066.9   97.9%        123
WHEEL&SHAFTASSY.     1617.6      1895.2     106.1   5.6%       8.0   0.4%    1781.1   94.0%         74

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:   31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:      8
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 RESOURCE QUEUE STATISTICS
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              AVERAGE                  MAXIMUM   AVERAGE      CURRENT    THE
RESOURCE      QUEUE      STANDARD      QUEUE     QUEUE        QUEUE      BLAKE
QUEUE         QUANTITY   DEVIATION     QUANTITY  WAIT(hrs)    QUANTITY   STATISTIC
```

403

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BALANCER  EQ     0.00       0.00       1.00      0.00          0        0.00
BE05      MP     0.07       0.34       4.00      0.69          0        0.05
BE09      MP     1.51       1.59       8.00      5.30          4        8.02
BE10      MP     0.90       1.19       5.00      5.71          0        5.11
BK10      MP     1.31       1.40       6.00      5.41          2        7.11
BOOTH     EQ     0.01       0.13       6.00      0.20          0        0.00
CHRM TNK  EQ     0.01       0.09       1.00      2.13          0        0.02
DB09      MP     3.03       3.81      20.00      3.07          3        9.30
DD09      MP     6.73       4.77      20.00      5.03          1       33.84
DD10      MP     2.17       2.09       5.00      5.95          0       12.92
DO05      MP     3.09       2.83      11.00      5.10          0       15.77
DRILL PR  EQ     0.00       0.07       3.00      0.52          0        0.00
F-25      EQ     0.00       0.00       0.00      0.00          0        0.00
FIC       EQ     0.06       0.24       1.00      3.55          0        0.22
FPI       EQ     0.00       0.00      18.00      0.00          0        0.00
GRINDER   EQ     0.01       0.21       8.00      0.37          0        0.01
JA09      MP     4.50       5.23      29.00      5.46          4       24.58
KH09      MP     0.15       0.40       2.00      5.48          0        0.80
LATHE     EQ     0.00       0.05       5.00      0.89          0        0.00
OVEN      EQ     0.03       0.16       1.00      0.78          0        0.02
PL. SPRY  EQ     0.00       0.00       1.00      0.00          0        0.00
PS09      MP     0.11       0.33       2.00      5.02          1        0.53
PT05      MP     0.58       1.13       7.00      5.43          2        3.13
RADL DR   EQ     0.00       0.04       3.00      0.34          0        0.00
SO4 ANDZ  EQ     0.01       0.12       3.00      0.30          0        0.00
STRIP     EQ     0.00       0.01       1.00      0.02          0        0.00
STRP TNK  EQ     0.00       0.00       1.00      0.00          0        0.00
UA09      MP     0.97       1.53      10.00      5.15          1        5.01
WELDER    EQ     0.00       0.00       2.00      0.00          0        0.00
WI09      MP     1.67       2.32      17.00      5.22          0        8.72
WJ09      MP     0.40       0.81       7.00      5.31          0        2.11
WK09      MP     0.46       0.86       6.00      5.20          0        2.40

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:    9
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ASSEMBLY STATISTICS
-------------------

                                      WAIT
                    TOTAL  DELAYED   (HOURS)  -------WAITING QUEUE COUNT -----
```

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PARENT ITEM       INDUCT  OPERATIONS  AVERAGE   AVERAGE STD.DEV. MAXIMUM CURRENT
-----------       ------  ----------  -------   ------- -------- ------- -------
GTE -180              73          73   2992.9      25.0      7.9    36.0      12
GTE -397             134         134   3246.9      49.8     14.5    69.0      27

ALC:  SA   RCC:  MATPGB   QUARTER:  4 DATE:  31-OCT-90  TIME:  11:57:13 REPT.ID: CUT 6     PAGE:   10
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WORK IN PROCESS
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                                                                              AVERAGE  AVERAGE  CURRENT
                  ALLOWABLE                                                   WAITING  QUANTITY QUANTITY
ITEM              QUANTITY  AVERAGE  STD.DEV. MINIMUM  MAXIMUM     CURRENT   TIME     WAITING  WAITING
-----------       --------  -------- -------- -------- --------    -------   -------- -------- --------
1ST.STG.COMPR.DIFF99999         7.9      4.3        0       16          3       ** NONE WAITED  *
1ST.STG.INLETASSY.99999        12.5      6.2        2       23          5       ** NONE WAITED **
2ND.STG.COMPR.DIFF99999        15.3      5.7        5       25          5       ** NONE WAITED **
2ND.STG.DIFF.ASSY 99999        49.8     14.5       19       69         27       ** NONE WAITED **
2ND.STG.DIFF.HSG. 99999        19.3      4.9       12       28         12       ** NONE WAITED **
2NDSTG.COMPR.HSG. 99999        17.9      6.5        7       29          8       ** NONE WAITED **
ACCESSORY CASE    99999         6.4      4.2        0       16          0       ** NONE WAITED **
BACKSHOP 180      99999        10.2      5.1        1       22          2       ** NONE WAITED **
BACKSHOP 397      99999        11.2      4.8        1       21          3       ** NONE WAITED **
BEARING HSG.      99999        24.8      8.3        7       36          7       ** NONE WAITED **
COMB. CHAMBER LNG.99999         6.3      3.8        0       15          2       ** NONE WAITED **
COMPRESSOR INLET  99999        24.4      9.2        3       41          7       ** NONE WAITED **
GTE -180          99999        27.2      8.7       13       40         13       ** NONE WAITED **
GTE -397          99999        53.4     15.0       22       75         32       ** NONE WAITED **
MATPSI 180 ONLY   99999         6.3      3.8        0       14          1       ** NONE WAITED **
MATPSI 397 ONLY   99999        12.1      6.9        0       24          0       ** NONE WAITED **
TORUS TURBINE     99999         9.4      4.4        2       18          3       ** NONE WAITED **
TURBINE BRG. HSG. 99999        35.1     10.4       12       51         22       ** NONE WAITED **
TURBINE NOZZLE 18099999        14.6      5.8        5       26          5       ** NONE WAITED **
TURBINE NOZZLE 39799999        35.7     10.5       10       53         21       ** NONE WAITED **
WHEEL&SHAFTASSY.  99999        16.2      6.2        5       26          5       ** NONE WAITED **

ALC:  SA   RCC:  MATPGB   QUARTER:  4 DATE:  31-OCT-90  TIME:  11:57:13 REPT.ID: CUT 6     PAGE:   11
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DEDICATED STOCK STATISTICS - Parallel Operations
------------------------------------------------

                        WAIT
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404

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STOCK ITEM           TOTAL  DELAYED     (HOURS)  -------WAITING QUEUE COUNT------
                     INDUCT OPERATIONS  AVERAGE  AVERAGE STD.DEV. MAXIMUM CURRENT
----------           ------ ----------  -------  ------- -------- ------- -------

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   12
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FLOATING STOCK STATISTICS
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                     FLOATING
                      STOCK    -QUANTITY IN STOCK & AVAILABLE FOR ASSEMBLY-
STOCK ITEM           QUANTITY  AVERAGE  STD.DEV.  MINIMUM  MAXIMUM  CURRENT
----------           --------  -------- --------  -------- -------- -------
1ST.STG.COMPR.DIFF          0     17.14     4.99      8.00    25.00       9
1ST.STG.INLETASSY.          0     12.53     2.94      7.00    20.00       7
2ND.STG.COMPR.DIFF          0      9.76     2.84      4.00    16.00       7
2ND.STG.DIFF.ASSY           0      0.00     0.00      0.00     0.00       0
2ND.STG.DIFF.HSG.           0      5.72     3.48      0.00    13.00       0
2NDSTG.COMPR.HSG.           0      7.08     2.48      2.00    12.00       4
ACCESSORY CASE              0     43.42    13.40     17.00    60.00      27
BACKSHOP 180                0     14.80     4.41      6.00    24.00      10
BACKSHOP 397                0     38.56    11.90     15.00    55.00      24
BEARING HSG.                0      0.25     1.01      0.00     7.00       5
COMB. CHAMBER LNG.          0     18.73     5.76     10.00    29.00      10
COMPRESSOR INLET            0     25.44     8.48      9.00    40.00      20
MATPSI 180 ONLY             0     18.69     5.55     10.00    28.00      11
MATPSI 397 ONLY             0     37.69    12.53     11.00    53.00      27
TORUS TURBINE               0     15.59     4.64      6.00    28.00       9
TURBINE BRG. HSG.           0     14.70     5.76      4.00    28.00       5
TURBINE NOZZLE 180          0     10.42     3.67      5.00    18.00       7
TURBINE NOZZLE 397          0     14.11     5.90      3.00    26.00       6
WHEEL&SHAFTASSY.            0      8.85     2.61      4.00    15.00       7

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   13
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 RESOURCE UTILIZATION by SHIFT
 -----------------------------

                                            ----AVERAGE NUMBER IN EACH STATE-----        ------BATCHING------
                          NUMBER  SHIFT                     PREV.            OTHER       MIN     MAX     AVG
CODE     DESCRIPTION SHIFT AVAIL.  UTIL.   IDLE   IN USE   MAINT.  FAILURE   DOWN        SIZE    SIZE    SIZE
-------------------  ----- ------  -----   ----   ------   ------  -------   -----       -----   -----   -----
BALANCER BAL             1    5.0   0.00   0.99     0.00     0.00     0.00    0.00
```

405

658

9074

```
                     2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

BE05    WG05         1    2.0   0.19  0.55   0.13    0.00    0.00    0.32
                     2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

BE09    WG09         1    9.0   0.20  0.54   0.14    0.00    0.00    0.32
                     2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

BE10    WG10         1    8.0   0.12  0.59   0.08    0.00    0.00    0.32
                     2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

BK10    WG10         1   10.0   0.15  0.58   0.10    0.00    0.00    0.32
                     2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

BOOTH   PNT          1    1.0   0.04  0.96   0.04    0.01    0.00    0.00       1.00     6.00     1.23
BATCH SZ    1 /  20  2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
```

```
only 80% of the workload and the other
20% may not be spread evenly across all
resources.

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   14
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 RESOURCE UTILIZATION by SHIFT
 ----------------------------

                                               ----AVERAGE NUMBER IN EACH STATE-----        ------BATCHING------
                                NUMBER  SHIFT                       PREV.           OTHER        MIN      MAX      AVG
CODE      DESCRIPTION     SHIFT AVAIL.  UTIL.    IDLE   IN USE   MAINT.  FAILURE    DOWN         SIZE     SIZE     SIZE
------------------------- ----- ------  -----    ----   ------   ------  -------   -----        ------   ------   ------   -
CHRM TNK TNK                1     1.0    0.01   0.98     0.01     0.01     0.00    0.00         1.00     1.00     1.00
BATCH SZ       1 /    10    2     0.0   NO VALUES RECORDED
                            3     0.0   NO VALUES RECORDED
                            4     0.0   NO VALUES RECORDED
                            5     0.0   NO VALUES RECORDED
                            6     0.0   NO VALUES RECORDED

DB09       INSP             1     2.0    0.12   0.62     0.08     0.00     0.00    0.29
                            2     0.0   NO VALUES RECORDED
                            3     0.0   NO VALUES RECORDED
                            4     0.0   NO VALUES RECORDED
                            5     0.0   NO VALUES RECORDED
                            6     0.0   NO VALUES RECORDED

DD09      WG09              1    10.0    0.71   0.19     0.48     0.00     0.00    0.32
                            2     0.0   NO VALUES RECORDED
                            3     0.0   NO VALUES RECORDED
                            4     0.0   NO VALUES RECORDED
                            5     0.0   NO VALUES RECORDED
                            6     0.0   NO VALUES RECORDED

DD10      WG10              1     5.0    0.53   0.32     0.36     0.00     0.00    0.32
                            2     0.0   NO VALUES RECORDED
                            3     0.0   NO VALUES RECORDED
                            4     0.0   NO VALUES RECORDED
                            5     0.0   NO VALUES RECORDED
                            6     0.0   NO VALUES RECORDED

DO05      WG05              1    11.0    0.36   0.43     0.24     0.00     0.00    0.32
                            2     0.0   NO VALUES RECORDED
```

407

660

```
                          3      0.0  NO VALUES RECORDED
                          4      0.0  NO VALUES RECORDED
                          5      0.0  NO VALUES RECORDED
                          6      0.0  NO VALUES RECORDED

DRILL PR DRILL            1      1.0    0.05   0.95   0.05     0.00     0.00     0.00
                          2      0.0  NO VALUES RECORDED
                          3      0.0  NO VALUES RECORDED
                          4      0.0  NO VALUES RECORDED
                          5      0.0  NO VALUES RECORDED
                          6      0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources.

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   15
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 RESOURCE UTILIZATION by SHIFT
 ---------------------------
                                            ----AVERAGE NUMBER IN EACH STATE-----            ------BATCHING------
                             NUMBER  SHIFT                   PREV.              OTHER     MIN      MAX      AVG
CODE      DESCRIPTION  SHIFT AVAIL.  UTIL.   IDLE   IN USE  MAINT.  FAILURE     DOWN     SIZE     SIZE     SIZE
-----------------------  -----  ------  -----   ----  ------  ------  -------     ----   ------   ------   ------
F-25       TEST CELL      1      7.0    0.14   0.86   0.14     0.00     0.00     0.00
                          2      7.0    0.02   0.98   0.02     0.00     0.00     0.00
                          3      7.0    0.01   0.99   0.01     0.00     0.00     0.00
                          4      7.0    0.00   0.99   0.00     0.00     0.00     0.00
                          5      7.0    0.00   1.00   0.00     0.00     0.00     0.00
                          6      7.0    0.00   1.00   0.00     0.00     0.00     0.00

FIC        FL. ION        1      1.0    0.12   0.83   0.12     0.03     0.02     0.00       1.00     1.00     1.00
BATCH SZ      1 /     6   2      0.0  NO VALUES RECORDED
                          3      0.0  NO VALUES RECORDED
                          4      0.0  NO VALUES RECORDED
                          5      0.0  NO VALUES RECORDED
                          6      0.0  NO VALUES RECORDED

FPI        FPI            1      2.0    0.08   0.92   0.08     0.00     0.00     0.00
                          2      0.0  NO VALUES RECORDED
                          3      0.0  NO VALUES RECORDED
```

804

661

H09

```
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

GRINDER  GRND        1    2.0   0.09  0.90   0.09    0.00    0.00    0.00
                     2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

JA09     MACH        1   21.0   0.08  0.65   0.05    0.00    0.00    0.29
                     2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

KH09     BAL         1    5.0   0.01  0.63   0.00    0.00    0.00    0.36
                     2    0.0  NO VALUES RECORDED
                     3    0.0  NO VALUES RECORDED
                     4    0.0  NO VALUES RECORDED
                     5    0.0  NO VALUES RECORDED
                     6    0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources.

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   16
----------------------------------------------------------------------------------------------------
 RESOURCE UTILIZATION by SHIFT
 -----------------------------
                                           ----AVERAGE NUMBER IN EACH STATE-----     ------BATCHING------
                           NUMBER  SHIFT                    PREV.             OTHER     MIN    MAX    AVG
CODE     DESCRIPTION SHIFT AVAIL.  UTIL.   IDLE  IN USE   MAINT.  FAILURE    DOWN      SIZE   SIZE   SIZE
------------------- ----- ------  -----   ----  ------   ------  -------    -----     ------ ------ ------

LATHE    LATHE         1   11.0    0.04   0.96   0.04     0.00     0.00     0.00
                       2    0.0   NO VALUES RECORDED
                       3    0.0   NO VALUES RECORDED
                       4    0.0   NO VALUES RECORDED
```

662

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                                5      0.0  NO VALUES RECORDED
                                6      0.0  NO VALUES RECORDED

OVEN      OVEN                  1      6.0    0.01   0.99    0.01    0.00    0.00    0.00        1.00    1.00    1.00
BATCH SZ      1 /       6       2      0.0  NO VALUES RECORDED
                                3      0.0  NO VALUES RECORDED
                                4      0.0  NO VALUES RECORDED
                                5      0.0  NO VALUES RECORDED
                                6      0.0  NO VALUES RECORDED

PL. SPRY PLASMA                 1      2.0    0.01   0.99    0.01    0.00    0.00    0.00
                                2      0.0  NO VALUES RECORDED
                                3      0.0  NO VALUES RECORDED
                                4      0.0  NO VALUES RECORDED
                                5      0.0  NO VALUES RECORDED
                                6      0.0  NO VALUES RECORDED

PS09      PS09                  1      2.0    0.01   0.72    0.01    0.00    0.00    0.28
                                2      0.0  NO VALUES RECORDED
                                3      0.0  NO VALUES RECORDED
                                4      0.0  NO VALUES RECORDED
                                5      0.0  NO VALUES RECORDED
                                6      0.0  NO VALUES RECORDED

PT05      PAINT                 1      3.0    0.02   0.66    0.01    0.00    0.00    0.33
                                2      0.0  NO VALUES RECORDED
                                3      0.0  NO VALUES RECORDED
                                4      0.0  NO VALUES RECORDED
                                5      0.0  NO VALUES RECORDED
                                6      0.0  NO VALUES RECORDED

RADL DR   DRILL                 1      5.0    0.08   0.92    0.08    0.00    0.00    0.00
                                2      0.0  NO VALUES RECORDED
                                3      0.0  NO VALUES RECORDED
                                4      0.0  NO VALUES RECORDED
                                5      0.0  NO VALUES RECORDED
                                6      0.0  NO VALUES RECORDED

Note:  Remember that the utilizations reflect
       only 80% of the workload and the other
       20% may not be spread evenly across all
       resources.
```

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ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   17
-----------------------------------------------------------------------------------------------------
 RESOURCE UTILIZATION by SHIFT
 -----------------------------
                                                ----AVERAGE NUMBER IN EACH STATE-----            ------BATCHING------
                              NUMBER  SHIFT                      PREV.            OTHER          MIN      MAX      AVG
CODE     DESCRIPTION    SHIFT AVAIL.  UTIL.     IDLE   IN USE   MAINT. FAILURE    DOWN          SIZE     SIZE     SIZE
------------------------ ----- ------  -----     ----   ------   ------ -------   -----         ------   ------   ------
SO4 ANDZ TNK               1    4.0     0.01    0.98     0.01     0.01    0.00     0.00          1.00     3.00     1.01
BATCH SZ       1 /     8   2    0.0   NO VALUES RECORDED
                           3    0.0   NO VALUES RECORDED
                           4    0.0   NO VALUES RECORDED
                           5    0.0   NO VALUES RECORDED
                           6    0.0   NO VALUES RECORDED

STRIP    TNK               1    1.0     0.01    0.98     0.01     0.01    0.00     0.00          1.00     1.00     1.00
BATCH SZ       1 /     5   2    0.0   NO VALUES RECORDED
                           3    0.0   NO VALUES RECORDED
                           4    0.0   NO VALUES RECORDED
                           5    0.0   NO VALUES RECORDED
                           6    0.0   NO VALUES RECORDED

STRP TNK TNK               1    1.0     0.01    0.99     0.01     0.00    0.00     0.00          1.00     1.00     1.00
BATCH SZ       1 /    10   2    0.0   NO VALUES RECORDED
                           3    0.0   NO VALUES RECORDED
                           4    0.0   NO VALUES RECORDED
                           5    0.0   NO VALUES RECORDED
                           6    0.0   NO VALUES RECORDED

UA09     PLATE             1    5.0     0.06    0.67     0.04     0.00    0.00     0.29
                           2    0.0   NO VALUES RECORDED
                           3    0.0   NO VALUES RECORDED
                           4    0.0   NO VALUES RECORDED
                           5    0.0   NO VALUES RECORDED
                           6    0.0   NO VALUES RECORDED

WELDER   WELD              1   15.0     0.01    0.98     0.01     0.00    0.00     0.00
                           2    0.0   NO VALUES RECORDED
                           3    0.0   NO VALUES RECORDED
                           4    0.0   NO VALUES RECORDED
                           5    0.0   NO VALUES RECORDED
```

114

664

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                    6     0.0  NO VALUES RECORDED

WI09     WELD       1     5.0   0.09  0.64    0.06     0.00     0.00     0.30
                    2     0.0  NO VALUES RECORDED
                    3     0.0  NO VALUES RECORDED
                    4     0.0  NO VALUES RECORDED
                    5     0.0  NO VALUES RECORDED
                    6     0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources.

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   18
-----------------------------------------------------------------------------------------------------
 RESOURCE UTILIZATION by SHIFT
 -----------------------------
                                         ----AVERAGE NUMBER IN EACH STATE-----         ------BATCHING------
                          NUMBER  SHIFT                    PREV.             OTHER        MIN       MAX      AVG
CODE     DESCRIPTION SHIFT AVAIL.  UTIL.   IDLE   IN USE  MAINT.  FAILURE    DOWN        SIZE      SIZE     SIZE
------------------- ----- ------  -----   ----   ------  ------  -------    -----       ------    ------   ------
WJ09     HT          1     7.0    0.01   0.70    0.01    0.00     0.00      0.29
                     2     0.0  NO VALUES RECORDED
                     3     0.0  NO VALUES RECORDED
                     4     0.0  NO VALUES RECORDED
                     5     0.0  NO VALUES RECORDED
                     6     0.0  NO VALUES RECORDED

WK09     WELD        1    10.0    0.02   0.69    0.01    0.00     0.00      0.30
                     2     0.0  NO VALUES RECORDED
                     3     0.0  NO VALUES RECORDED
                     4     0.0  NO VALUES RECORDED
                     5     0.0  NO VALUES RECORDED
                     6     0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   19
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H12

665

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 ITEM NAME: 1ST.STG.COMPR.DIFF WCD NAME: TG624D

WCD by OPERATION STATISTIC AVERAGES
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                                                   AVERAGE    AVERAGE
 OPER  POTENTIAL PROCESSED  QUEUED    QUEUED   SCHEDULED  SIMULATED                 OCC
 CODE     QTY       QTY       QTY       HRS        HRS        HRS      DESC  RCC    FAC
 ----  --------  --------  ---------  --------  ---------  ---------  ----  ------  ----
 0100     73.       73.        0.       0.00     238.00     238.12    IN    MATPNC  1.00
 0140     74.       74.       58.      22.00       0.18       0.43    PROC  MATPNC  1.00  JA09,LATHE
 0199     74.       74.        0.       0.00      30.79      30.79    OUT   MATPNC  1.00
 0200     74.       57.        0.       0.00     146.05     143.52    IN    MATPNB  0.71
 0240     73.       48.       40.      19.54       0.21       0.21    PROC  MATPNB  0.71  DB09,FPI
 0299     73.       48.        0.       0.00      35.32      35.32    OUT   MATPNB  0.71
 0300     73.       51.        0.       0.00     343.82     339.59    IN    MAEIAA  0.71
 0340     72.       46.       31.      17.70       0.19       0.19    PROC  MAEIAA  0.71  UA09,SO4ANDZ(be
 0399     72.       46.        0.       0.00      35.36      35.36    OUT   MAEIAA  0.71
 0400     72.       57.        0.       0.00     253.17     242.28    IN    MATPNC  0.86
 0440     73.       69.       55.      16.26       0.19       0.46    PROC  MATPNC  0.86  JA09
 0499     73.       68.        0.       0.00      30.33      30.33    OUT   MATPNC  0.86
ALC:   SA    RCC:  MATPGB   QUARTER:  4  DATE:   31-OCT-90  TIME:   11:57:13  REPT.ID: CUT 6    PAGE:   20
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 ITEM NAME; 1ST.STG.INLETASSY. WCD NAME: TG623D

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                   AVERAGE    AVERAGE
 OPER  POTENTIAL PROCESSED  QUEUED    QUEUED   SCHEDULED  SIMULATED                 OCC
 CODE     QTY       QTY       QTY       HRS        HRS        HRS      DESC  RCC    FAC
 ----  --------  --------  ---------  --------  ---------  ---------  ----  ------  ----
 0100     73.       62.        0.       0.00     572.04     559.62    IN    MATPNC  0.83
 0140     73.       59.       42.      20.80       1.69       4.03    PROC  MATPNC  0.83  JA09,LATHE
 0199     73.       64.        0.       0.00      32.24      32.24    OUT   MATPNC  0.83
 0200     73.       42.        0.       0.00      52.53      52.53    IN    MATPNB  0.61
 0240     73.       46.       38.      20.89       0.21       0.21    PROC  MATPNB  0.61  DB09,FPI
 0299     73.       44.        0.       0.00      33.94      33.94    OUT   MATPNB  0.61
 0300     73.       51.        0.       0.00     314.13     296.70    IN    MAEIAA  0.67
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413

666

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0340     72.     45.     35.     22.26     0.37     0.77    PROC  MAEIAA  0.67  UA09,SO4ANDZ(be
0399     72.     49.      0.      0.00    33.87    33.87    OUT   MAEIAA  0.67
0400     72.     37.      0.      0.00   258.24   258.24    IN    MATPNN  0.56
0440     72.     39.     23.     19.61     1.00     3.18    PROC  MATPNN  0.56  WI09,WELDER
0499     72.     42.      0.      0.00    36.47    36.47    OUT   MATPNN  0.56
0500     72.     50.      0.      0.00   433.47   433.47    IN    MATPNC  0.67
0540     72.     46.     34.     21.36     1.13     3.37    PROC  MATPNC  0.67  JA09,LATHE
0599     72.     47.      0.      0.00    39.30    39.30    OUT   MATPNC  0.67
0600     72.      4.      0.      0.00    44.20    44.20    IN    MATPNB  0.06
0640     72.      4.      4.      8.50     0.21     0.21    PROC  MATPNB  0.06  DB09,FPI
0699     72.      3.      0.      0.00    13.46    13.46    OUT   MATPNB  0.06
0700     72.      3.      0.      0.00    24.83    24.83    IN    MATPNC  0.06
0740     72.      4.      4.     20.02     1.13     1.13    PROC  MATPNC  0.06  JA09,LATHE
0799     73.      4.      0.      0.00     3.25     3.25    OUT   MATPNC  0.06
0800     73.     51.      0.      0.00   175.77   175.77    IN    MATPNB  0.72
0840     73.     52.     38.     15.85     0.21     0.21    PROC  MATPNB  0.72  DB09,FPI
0899     73.     58.      0.      0.00    32.04    31.13    OUT   MATPNB  0.72

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   21
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 ITEM NAME:  2ND.STG.COMPR.DIFF WCD NAME:  TG629D

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                    AVERAGE      AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED    QUEUED     SCHEDULED    SIMULATED                  OCC
 CODE     QTY       QTY        QTY       HRS         HRS          HRS      DESC   RCC     FAC
 ----  --------  --------  ---------- --------   ----------   ----------   ----  ------  ----
0100     73.       42.         0.       0.00       508.93       508.93     IN    MATPNC  0.53
0140     73.       33.        13.      18.85         0.26         0.82     PROC  MATPNC  0.53  JA09,LATHE
0199     73.       46.         0.       0.00        33.57        33.57     OUT   MATPNC  0.53
0200     73.       15.         0.       0.00       242.79       242.79     IN    MATPNN  0.18
0240     73.       16.         9.      29.47         1.25         1.25     PROC  MATPNN  0.18  WK09,WELDER
0299     73.       16.         0.       0.00        43.35        43.35     OUT   MATPNN  0.18
0300     73.       35.         0.       0.00       791.59       781.85     IN    MATPNC  0.41
0340     73.       35.        27.      14.91         0.27         0.79     PROC  MATPNC  0.41  JA09,LATHE
0399     73.       30.         0.       0.00        31.48        31.48     OUT   MATPNC  0.41
0400     73.       59.         0.       0.00       106.04       106.60     IN    MATPNB  0.88
0440     74.       67.        57.      17.81         0.21         0.48     PROC  MATPNB  0.88  DB09,FPI
0499     74.       69.         0.       0.00        37.98        37.98     OUT   MATPNB  0.88
```

414

667

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 0500     74.     66.        0.      0.00    935.84   1027.75    IN    MAEIAA   0.94
 0540     77.     73.       62.     23.28      0.30      0.30    PROC  MAEIAA   0.94   UA09,SO4ANDZ(be
 0599     78.     72.        0.      0.00     35.84     35.84    OUT   MAEIAA   0.94

ALC:   SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   22
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 ITEM NAME:  2ND.STG.DIFF.ASSY  WCD NAME:  TA813F

WCD by OPERATION STATISTIC AVERAGES
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                                                   AVERAGE    AVERAGE
  OPER  POTENTIAL PROCESSED   QUEUED    QUEUED   SCHEDULED  SIMULATED                  OCC
  CODE     QTY       QTY        QTY       HRS        HRS        HRS      DESC   RCC    FAC
  ----  --------  --------  --------  --------  ---------  ---------     ----  ------  ----
 0100     134.     134.        0.      0.00    121.23     121.23     IN    MATPNC   1.00
 0140     134.     134.      110.     22.45      0.32       0.82     PROC  MATPNC   1.00   JA09,DRILLER
 0199     134.     134.        0.      0.00     33.28      33.28     OUT   MATPNC   1.00
 0200     134.     118.        0.      0.00    160.18     160.18     IN    MATPNB   0.90
 0240     134.     123.      100.     19.54      0.21       0.21     PROC  MATPNB   0.90   DB09,FPI
 0299     134.     121.        0.      0.00     32.98      32.98     OUT   MATPNB   0.90
 0300     134.     123.        0.      0.00    118.83     118.83     IN    MATPNN   0.90
 0340     134.     123.      100.     24.11      0.90       1.50     PROC  MATPNN   0.90   WK09,WELDER
 0399     134.     124.        0.      0.00     32.00      32.00     OUT   MATPNN   0.90
 0400     134.     122.        0.      0.00     24.60      24.60     IN    MAEPDB   0.90
 0440     134.     124.       94.     20.81      0.50       1.86     PROC  MAEPDB   0.90   WJ09,OVEN(be)
 0499     134.     120.        0.      0.00      8.85       8.85     OUT   MAEPDB   0.90
 0500     134.     120.        0.      0.00    329.35     329.35     IN    MATPNC   0.90
 0540     134.     118.      102.     20.43      0.30       1.02     PROC  MATPNC   0.90   JA09,LATHE
 0599     134.     120.        0.      0.00     36.31      36.31     OUT   MATPNC   0.90
 0600     134.     122.        0.      0.00     86.27      86.27     IN    MATPNB   0.90
 0640     134.     125.      104.     21.79      0.21       0.21     PROC  MATPNB   0.90   DB09,FPI
 0699     134.     122.        0.      0.00     32.67      32.67     OUT   MATPNB   0.90
 0700     134.     106.        0.      0.00    165.27     165.27     IN    MATPNN   0.80
 0740     134.     110.       89.     18.28      1.27       2.21     PROC  MATPNN   0.80   WI09,WELDER
 0799     134.     114.        0.      0.00     35.27      35.27     OUT   MATPNN   0.80
 0800     134.     134.        0.      0.00    451.41     454.38     IN    MATPNC   1.00
 0840     132.     132.      114.     19.55      0.30       1.59     PROC  MATPNC   1.00   JA09,RADLDR
 0899     131.     131.        0.      0.00     31.82      31.82     OUT   MATPNC   1.00
 0900     131.      54.        0.      0.00     47.06      47.17     IN    MATPNB   0.50
 0940     132.      62.       49.     20.44      0.21       0.21     PROC  MATPNB   0.50   DB09,FPI
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668

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 0999     132.      61.        0.      0.00      35.29       35.29      OUT    MATPNB   0.50
 1000     132.     121.        0.      0.00     607.05      596.39      IN     MATPMM   0.90
 1040     130.     112.       91.     20.29       0.26        0.43      PROC   MATPMM   0.90  PT05,BOOTH(be)
 1099     129.     116.        0.      0.00      30.34       30.34      OUT    MATPMM   0.90
 1100     129.     129.        0.      0.00     931.90      878.08      IN     MATPNC   1.00
 1140     127.     127.      108.     19.64       2.11        3.93      PROC   MATPNC   1.00  JA09,RADLDR
 1199     128.     128.        0.      0.00      33.26       33.26      OUT    MATPNC   1.00
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6   PAGE:   23
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 ITEM NAME: 2ND.STG.DIFF.HSG.  WCD NAME: TG628D

WCD by OPERATION STATISTIC AVERAGES
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                                                   AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED    QUEUED    QUEUED    SCHEDULED   SIMULATED                   OCC
 CODE     QTY       QTY         QTY       HRS        HRS         HRS      DESC   RCC      FAC
 ----  --------  --------  ---------- -------  ----------  ----------   ----   ------   ----
 0100     73.      63.         0.      0.00    1256.07     1235.15      IN     MATPNC   0.83
 0140     73.      60.        45.     21.45       0.22        1.31      PROC   MATPNC   0.83  JA09
 0199     74.      60.         0.      0.00      35.50       35.50      OUT    MATPNC   0.83
 0200     74.      24.         0.      0.00     870.57      969.46      IN     MAEIAA   0.50
 0240     76.      43.        29.     24.73       0.19        2.16      PROC   MAEIAA   0.50  UA09,SO4ANDZ(be
 0299     76.      34.         0.      0.00      32.01       32.01      OUT    MAEIAA   0.50
 0300     76.      44.         0.      0.00     516.18      565.37      IN     MATPNN   0.67
 0340     77.      61.        46.     17.52       0.26        1.35      PROC   MATPNN   0.67  WI09,WELDER
 0399     77.      49.         0.      0.00      30.90       30.90      OUT    MATPNN   0.67
 0400     77.      28.         0.      0.00     813.09      935.64      IN     MATPNC   0.33
 0440     76.      19.        10.     20.19       0.75        1.72      PROC   MATPNC   0.33  JA09,RADLDR
 0499     76.      22.         0.      0.00      33.27       33.27      OUT    MATPNC   0.33
 0500     76.       0.         0.      0.00       0.00        0.00      IN     MATPNB   0.01
 0540     76.       0.         0.      0.00       0.00        0.00      PROC   MATPNB   0.01
 0599     76.       1.         0.      0.00       7.98        7.98      OUT    MATPNB   0.01
 0600     76.       1.         0.      0.00      35.56       35.56      IN     MATPNN   0.01
 0640     76.       0.         0.      0.00       0.00        0.00      PROC   MATPNN   0.01
 0699     76.       1.         0.      0.00      52.14       52.14      OUT    MATPNN   0.01
 0700     76.      14.         0.      0.00      84.09       84.09      IN     MATPNC   0.17
 0740     76.      13.        10.     21.56       0.75        5.86      PROC   MATPNC   0.17  JA09,LATHE
 0799     76.       8.         0.      0.00      33.35       33.35      OUT    MATPNC   0.17
 0800     76.       3.         0.      0.00      21.63       21.63      IN     MATPNB   0.01
 0840     76.       1.         1.     22.04       0.21        0.21      PROC   MATPNB   0.01  DB09,FPI
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0899      76.       1.        0.       0.00     76.62       76.62      OUT   MATPNB  0.01
0900      76.       2.        0.       0.00     40.00       40.00      IN    MATPNN  0.01
0940      76.       1.        0.       0.00      0.26        0.26      PROC  MATPNN  0.01
0999      76.       0.        0.       0.00      0.00        0.00      OUT   MATPNN  0.01
1000      76.       1.        0.       0.00      2.11        2.11      IN    MATPNC  0.01
1040      76.       0.        0.       0.00      0.00        0.00      PROC  MATPNC  0.01
1099      76.       3.        0.       0.00     36.68       36.68      OUT   MATPNC  0.01
1100      76.      46.        0.       0.00     30.33       30.33      IN    MATPNB  0.50
1140      76.      35.       24.      21.09      0.21        0.74      PROC  MATPNB  0.50  DB09,FPI
1199      75.      41.        0.       0.00     17.89       17.89      OUT   MATPNB  0.50
1200      75.      31.        0.       0.00     43.89       43.89      IN    MATPNC  0.50
1240      75.      33.       20.      22.80      1.00        3.56      PROC  MATPNC  0.50  JA09
1299      75.      37.        0.       0.00     27.95       27.95      OUT   MATPNC  0.50
1300      75.      25.        0.       0.00     38.83       38.83      IN    MATPMM  0.33
1340      75.      26.       19.      17.30      0.26        0.26      PROC  MATPMM  0.33  PT05,BOOTH(be)
1399      75.      19.        0.       0.00     34.64       34.64      OUT   MATPMM  0.33

ALC:  SA   RCC:  MATPGB   QUARTER:  4 DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   24
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 ITEM NAME: 2NDSTG.COMPR.HSG.  WCD NAME: TG622D

WCD by OPERATION STATISTIC AVERAGES
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                                                      AVERAGE      AVERAGE
 OPER  POTENTIAL PROCESSED    QUEUED     QUEUED     SCHEDULED    SIMULATED                   OCC
 CODE     QTY       QTY         QTY        HRS         HRS          HRS       DESC   RCC     FAC
 ----  --------  --------  ----------  --------   ----------   ----------     ----  ------   ----
0100      73.       73.         0.       0.00      511.84       508.28      IN    MATPNC  1.00
0140      74.       74.        63.      19.00        1.24         1.74      PROC  MATPNC  1.00  JA09,LATHE
0199      74.       74.         0.       0.00       34.40        34.40      OUT   MATPNC  1.00
0200      74.       67.         0.       0.00      126.59       127.53      IN    MATPNB  0.80
0240      75.       59.        46.      24.42        0.21         0.21      PROC  MATPNB  0.80  DB09,FPI
0299      75.       55.         0.       0.00       40.98        40.98      OUT   MATPNB  0.80
0300      75.       69.         0.       0.00      293.11       290.39      IN    MAEIAA  0.90
0340      75.       68.        49.      19.90        0.25         0.52      PROC  MAEIAA  0.90  UA09,SO4ANDZ(be
0399      75.       69.         0.       0.00       39.47        39.47      OUT   MAEIAA  0.90
0400      75.       63.         0.       0.00      414.71       410.11      IN    MATPNN  0.80
0440      74.       61.        48.      21.85        1.00         1.30      PROC  MATPNN  0.80  WI09
0499      74.       59.         0.       0.00       26.38        26.38      OUT   MATPNN  0.80
0500      74.       50.         0.       0.00      767.01       797.61      IN    MATPNC  0.70
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 0540      73.      51.      41.     22.60      1.24      1.24    PROC   MATPNC   0.70  JA09,RADI.DR
 0599      73.      52.       0.      0.00     36.77     36.77    OUT    MATPNC   0.70
 0600      73.       0.       0.      0.00      0.00      0.00    IN     MATPNB   0.01
 0640      73.       1.       1.     15.13      0.21      0.21    PROC   MATPNB   0.01  DB09,FPI
 0699      73.       2.       0.      0.00     14.99     14.99    OUT    MATPNB   0.01
 0700      73.       2.       0.      0.00     23.35     23.35    IN     MATPNC   0.01
 0740      73.       0.       0.      0.00      0.00      0.00    PROC   MATPNC   0.01
 0799      73.       1.       0.      0.00     64.87     64.88    OUT    MATPNC   0.01
 0800      73.      62.       0.      0.00    121.57    121.57    IN     MATPNB   0.80
 0840      73.      56.      47.     21.89      0.21      0.21    PROC   MATPNB   0.80  DB09,FPI
 0899      73.      59.       0.      0.00     30.44     30.71    OUT    MATPNB   0.80

ALC:  SA   RCC:  MATPGB  QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:  25
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 ITEM NAME: ACCESSORY CASE     WCD NAME: TA537F

WCD by OPERATION STATISTIC AVERAGES
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                                                    AVERAGE      AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED    QUEUED     SCHEDULED    SIMULATED                    OCC
 CODE     QTY       QTY        QTY       HRS         HRS          HRS      DESC    RCC      FAC
 ----  --------  --------  ---------  --------  ----------  -----------  ----   ------    ----
 0000     134.      111.        0.      0.00      127.65       127.65    IN     MATPNC   0.81
 0010     134.      105.       63.     18.57        1.25         2.76    MACH   MATPNC   0.81  JA09,LATHE
 0199     134.      111.        0.      0.00       30.14        30.14    OUT    MATPNC   0.81
 0200     134.        3.        0.      0.00       23.12        23.12    IN     MATPNN   0.01
 0240     134.        2.        2.     31.19        0.32         0.32    PROC   MATPNN   0.01  WK09,WELDER
 0299     134.        1.        0.      0.00        0.00         0.00    OUT    MATPNN   0.01
 0300     134.        0.        0.      0.00        0.00         0.00    IN     MATPNB   0.01
 0340     134.        2.        2.     49.32        0.21         0.21    PROC   MATPNB   0.01  DB09,FPI
 0399     134.        1.        0.      0.00       55.19        55.19    OUT    MATPNB   0.01
 0400     134.        1.        0.      0.00       24.00        24.00    IN     MAEPDB   0.01
 0440     134.        2.        0.      0.00        1.40        10.55    PROC   MAEPDB   0.01
 0499     134.        1.        0.      0.00       19.29        19.29    OUT    MAEPDB   0.01
 0500     134.        0.        0.      0.00        0.00         0.00    IN     MATPNC   0.01
 0540     134.        1.        1.      0.71        0.50         0.50    PROC   MATPNC   0.01  JA09,GRINDER
 0599     134.        2.        0.      0.00       68.94        68.94    OUT    MATPNC   0.01
 0600     134.        9.        0.      0.00       15.11        15.11    IN     MATPNB   0.09
 0640     134.       15.        9.     17.96        0.21         0.21    PROC   MATPNB   0.09  DB09,FPI
 0699     134.       10.        0.      0.00       10.23        10.23    OUT    MATPNB   0.09
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#18

671

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0700   134.    17.      0.     0.00   137.79   137.79   IN    MATPNC   0.14
0740   134.    23.     13.    16.97     2.59     8.68   PROC  MATPNC   0.14  JA09,DRILLPR
0799   134.    24.      0.     0.00    30.09    30.09   OUT   MATPNC   0.14
0800   134.    92.      0.     0.00    95.21    95.21   IN    MATPNB   0.76
0840   134.   106.     86.    19.44     0.21     0.21   PROC  MATPNB   0.76  DB09,FPI
0899   134.    93.      0.     0.00    34.65    34.65   OUT   MATPNB   0.76
0900   134.    88.      0.     0.00    29.97    29.97   IN    MATPSI   0.67
0940   134.    83.     61.    18.54     0.25     1.28   PROC  MATPSI   0.67  DO05
0999   134.    78.      0.     0.00    34.63    34.63   OUT   MATPSI   0.67
1000   134.    84.      0.     0.00    94.82    94.82   IN    MATPMM   0.67
1040   134.    86.     68.    16.86     0.27     0.49   PROC  MATPMM   0.67  PT05,BOOTH(be)
1099   134.    95.      0.     0.00    31.71    31.71   OUT   MATPMM   0.67
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:   26
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 ITEM NAME: BACKSHOP 180       WCD NAME: BS180

WCD by OPERATION STATISTIC AVERAGES
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                                                  AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED    QUEUED   SCHEDULED   SIMULATED                  OCC
 CODE     QTY       QTY        QTY       HRS        HRS         HRS      DESC   RCC    FAC
 ----  --------  --------  ---------  --------  ---------  ----------   ----  ------  ----
 0001     73.       73.         0.       0.00    1175.91     1189.18    PROC  MATALL  1.00
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:   27
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 ITEM NAME: BACKSHOP 397       WCD NAME: BS397

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                  AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED    QUEUED   SCHEDULED   SIMULATED                  OCC
 CODE     QTY       QTY        QTY       HRS        HRS         HRS      DESC   RCC    FAC
 ----  --------  --------  ---------  --------  ---------  ----------   ----  ------  ----
 0001    134.      134.         0.       0.00     739.21      704.04    PROC  MATALL  1.00
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:   28
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#19

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6073

#420

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 ITEM NAME: BEARING HSG.       WCD NAME: TG631D

WCD by OPERATION STATISTIC AVERAGES
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                                                        AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED      QUEUED    QUEUED   SCHEDULED   SIMULATED              OCC
 CODE     QTY       QTY          QTY       HRS        HRS         HRS      DESC  RCC    FAC
 ----  --------  --------   ---------- --------   ---------   ----------   ----  ------ ----
 0100     73.       42.          0.       0.00     503.75      477.15     IN    MATPNC 0.59
 0140     72.       51.         22.      18.26       0.38        0.38     PROC  MATPNC 0.59  JA09
 0199     72.       44.          0.       0.00      33.04       33.04     OUT   MATPNC 0.59
 0200     72.        4.          0.       0.00     113.44      113.44     IN    MATPNB 0.05
 0240     72.        4.          2.      13.86       0.21        0.21     PROC  MATPNB 0.05  DB09,FPI
 0299     72.        4.          0.       0.00      43.74       43.74     OUT   MATPNB 0.05
 0300     72.       15.          0.       0.00    1680.75     2694.73     IN    MATPNC 0.23
 0340     75.       20.         12.      22.19       1.05        2.90     PROC  MATPNC 0.23  JA09,GRINDER
 0399     75.       19.          0.       0.00      45.84       45.84     OUT   MATPNC 0.23
 0400     75.       51.          0.       0.00     282.25      279.09     IN    MATPNB 0.77
 0440     76.       50.         40.      16.17       0.21        1.51     PROC  MATPNB 0.77  DB09,FPI
 0499     77.       60.          0.       0.00      25.99       25.99     OUT   MATPNB 0.77
 0500     77.       56.          0.       0.00      35.24       35.24     IN    MATPNN 0.73
 0540     77.       65.         46.      19.02       0.25        0.53     PROC  MATPNN 0.73  WI09
 0599     78.       55.          0.       0.00      30.84       30.84     OUT   MATPNN 0.73
 0600     78.       58.          0.       0.00     122.93      122.93     IN    MATPNC 0.73
 0640     78.       61.         52.      20.10       1.05        2.72     PROC  MATPNC 0.73  JA09,GRINDER
 0699     79.       60.          0.       0.00      32.21       32.21     OUT   MATPNC 0.73
 0700     79.       57.          0.       0.00      69.35       69.35     IN    MATPNB 0.73
 0740     79.       57.         44.      23.62       0.21        0.21     PROC  MATPNB 0.73  DB09,FPI
 0799     79.       56.          0.       0.00      29.19       29.19     OUT   MATPNB 0.73
 0800     79.       48.          0.       0.00     678.44      678.44     IN    MATPNC 0.68
 0840     79.       45.         35.      16.68       0.84        1.24     PROC  MATPNC 0.68  JA09,LATHE
 0899     80.       60.          0.       0.00      37.54       37.54     OUT   MATPNC 0.68
 0900     80.        2.          0.       0.00       5.85        5.85     IN    MAEIAA 0.01
 0940     80.        1.          1.       3.10       1.50        1.50     PROC  MAEIAA 0.01  UA09,CHRMTNK(be
 0999     80.        0.          0.       0.00       0.00        0.00     OUT   MAEIAA 0.01
 1000     80.       59.          0.       0.00     111.28      111.28     IN    MATPNC 0.68
 1040     80.       62.         53.      17.21       1.05        2.12     PROC  MATPNC 0.68  JA09,GRINDER
 1099     80.       48.          0.       0.00      32.74       32.74     OUT   MATPNC 0.68
 1100     80.        3.          0.       0.00      27.89       27.89     IN    MATPNN 0.09
 1140    80.      7.        4.      9.27      1.69     11.19     PROC   MATPNN   0.09  WI09,WELDER
 1199    80.      5.        0.      0.00     37.15     37.15     OUT    MATPNN   0.09
 1200    80.     11.        0.      0.00    808.19    808.19     IN     MATPNC   0.14
 1240    80.     11.        7.     12.33      1.05      1.05     PROC   MATPNC   0.14  JA09,GRINDER
 1299    80.     10.        0.      0.00     22.34     22.34     OUT    MATPNC   0.14
 1300    80.     45.        0.      0.00    233.06    251.79     IN     MATPNB   0.64
 1340    81.     49.       38.     19.68      0.21      0.59     PROC   MATPNB   0.64  DB09,FPI
 1399    81.     51.        0.      0.00     33.36     33.36     OUT    MATPNB   0.64
 1400    81.     50.        0.      0.00     15.40     15.40     IN     MATPNN   0.59
 1440    81.     57.       40.     19.40      0.25      0.25     PROC   MATPNN   0.59  WI09
 1499    81.     49.        0.      0.00     18.59     18.59     OUT    MATPNN   0.59
 1500    81.      8.        0.      0.00     23.91     23.91     IN     MATPNC   0.14
 1540    81.     12.        9.     23.94      2.38      3.91     PROC   MATPNC   0.14  JA09,LATHE
 1599    81.     17.        0.      0.00     35.16     35.16     OUT    MATPNC   0.14
 1600    81.     49.        0.      0.00    945.55    876.85     IN     MATPNB   0.50
 1640    79.     37.       28.     17.43      0.21      2.00     PROC   MATPNB   0.50  DB09,FPI
 1699    79.     44.        0.      0.00     38.51     38.51     OUT    MATPNB   0.50

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   29
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 ITEM NAME: COMB. CHAMBER LNG. WCD NAME: TG611D

WCD by OPERATION STATISTIC AVERAGES
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                                                   AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED    QUEUED    SCHEDULED   SIMULATED                    OCC
 CODE     QTY       QTY        QTY       HRS        HRS         HRS       DESC   RCC      FAC
 ----  --------  --------  ---------  --------  ----------  ----------    ----   ------   ----
 0100    73.       52.         0.      0.00      28.25       28.25       IN     MATPNN   0.67
 0140    73.       55.        32.     24.36       0.52        2.93       PROC   MATPNN   0.67  WI09
 0199    73.       45.         0.      0.00      33.39       33.39       OUT    MATPNN   0.67
 0200    73.       51.         0.      0.00      32.79       32.79       IN     MATPNC   0.73
 0240    73.       54.        41.     20.48       0.16        0.16       PROC   MATPNC   0.73  JA09,RADLDR
 0299    73.       57.         0.      0.00      36.85       36.85       OUT    MATPNC   0.73
 0300    73.       69.         0.      0.00      12.72       12.72       IN     MATPNB   0.93
 0340    73.       69.        60.     23.97       0.21        0.21       PROC   MATPNB   0.93  DB09,FPI
 0399    73.       68.         0.      0.00      16.43       16.43       OUT    MATPNB   0.93
 0400    73.       66.         0.      0.00     115.69      114.82       IN     MATPNN   0.87
 0440    74.       69.        55.     16.49       0.75        2.23       PROC   MATPNN   0.87  WI09
 0499    75.       66.         0.      0.00      35.66       35.66       OUT    MATPNN   0.87
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0500     75.     55.      0.     0.00      15.24      15.24     IN    MATPNC  0.73
0540     75.     57.     41.    21.99       0.16       0.16     PROC  MATPNC  0.73  JA09,LATHE
0589     76.     51.      0.     0.00      17.47      17.47     OUT   MATPNC  0.73
0510     76.     38.      0.     0.00      21.68      21.68     IN    MATPNN  0.60
0550     76.     44.     32.    18.50       0.82       1.65     PROC  MATPNN  0.60  WI09,WELDER
0599     76.     48.      0.     0.00      32.75      32.75     OUT   MATPNN  0.60
0600     76.     42.      0.     0.00      22.48      22.48     IN    MAEPDB  0.47
0640     76.     34.     22.    18.94       0.54       1.08     PROC  MAEPDB  0.47  WJ09,OVEN(be)
0699     76.     39.      0.     0.00      10.81      10.81     OUT   MAEPDB  0.47
0700     76.     56.      0.     0.00      16.67      16.67     IN    MATPNC  0.73
0740     76.     59.     46.    22.10       0.16       0.16     PROC  MATPNC  0.73  JA09,RADLDR
0799     76.     48.      0.     0.00      16.97      16.97     OUT   MATPNC  0.73
0800     76.     45.      0.     0.00      30.23      30.23     IN    MATPNN  0.60
0840     76.     49.     30.    20.15       0.48       0.86     PROC  MATPNN  0.60  WI09,WELDER
0899     76.     49.      0.     0.00       8.26       8.26     OUT   MATPNN  0.60
0900     76.     76.      0.     0.00      26.99      26.99     IN    MATPNB  1.00
0940     76.     76.     63.    23.26       0.21       0.21     PROC  MATPNB  1.00  DB09,FPI
0999     76.     76.      0.     0.00      15.34      15.34     OUT   MATPNB  1.00
1000     76.     65.      0.     0.00      93.96      95.04     IN    MAEPCA  0.87
1040     76.     65.     50.    16.72       0.50       1.07     PROC  MAEPCA  0.87  PS09,PL.SPRY
1099     75.     67.      0.     0.00      37.51      37.51     OUT   MAEPCA  0.87
1100     75.     55.      0.     0.00      29.21      29.21     IN    MATPNN  0.73
1140     75.     58.     44.    20.60       0.75       4.30     PROC  MATPNN  0.73  WI09
1199     75.     54.      0.     0.00      37.32      37.32     OUT   MATPNN  0.73
ALC:  SA  RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:  30
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 ITEM NAME: COMPRESSOR INLET   WCD NAME: TG816F

WCD by OPERATION STATISTIC AVERAGES
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                                                   AVERAGE    AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED    QUEUED   SCHEDULED  SIMULATED                   OCC
 CODE     QTY       QTY        QTY       HRS        HRS        HRS       DESC   RCC     FAC
 ----  --------  --------  ---------  --------  ---------  ---------     ----  ------  ----
 0100    134.       14.        0.       0.00      87.37      87.37     IN    MATPNC  0.09
 0140    134.        7.        0.       0.00       0.43       0.43     PROC  MATPNC  0.09
 0199    134.        5.        0.       0.00      20.15      20.15     OUT   MATPNC  0.09
 0200    134.        7.        0.       0.00     198.99     196.99     IN    MATPNN  0.05
 0240    134.        7.        2.       8.88       1.00       1.00     PROC  MATPNN  0.05  WI09,WELDER
 0299    134.        6.        0.       0.00      33.33      33.33     OUT   MATPNN  0.05
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 0400     134.       8.        0.        0.00     627.77      627.77     IN     MATPNC   0.09
 0440     134.      12.        6.        5.34       0.40        0.40     PROC   MATPNC   0.09  JA09,GRINDER
 0499     134.      14.        0.        0.00      39.52       39.52     OUT    MATPNC   0.09
 0500     134.      19.        0.        0.00      72.87       72.87     IN     MATPNB   0.14
 0540     134.      27.        6.       25.43       0.21        0.21     PROC   MATPNB   0.14  DB09,FPI
 0599     134.      12.        0.        0.00      35.62       35.62     OUT    MATPNB   0.14
 0600     134.     130.        0.        0.00     812.03      799.64     IN     MAEIAA   0.95
 0640     134.     124.       98.       18.95       0.30        0.45     PROC   MAEIAA   0.95  UA09,SO4ANDZ(be
 0699     133.     129.        0.        0.00      31.73       31.73     OUT    MAEIAA   0.95
 0700     133.     114.        0.        0.00     675.64      706.63     IN     MATPNC   0.82
 0740     131.     111.       90.       19.53       0.40        0.56     PROC   MATPNC   0.82  JA09,GRINDER
 0799     131.     113.        0.        0.00      32.63       32.63     OUT    MATPNC   0.82
 0800     131.      83.        0.        0.00      61.82       61.82     IN     MATPNB   0.64
 0840     131.      85.       71.       18.99       0.21        0.21     PROC   MATPNB   0.64  DB09,FPI
 0899     132.      88.        0.        0.00      34.25       34.25     OUT    MATPNB   0.64
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   31
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 ITEM NAME: GTE -180          WCD NAME: 13095A

WCD by OPERATION STATISTIC AVERAGES
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                                                         AVERAGE     AVERAGE
  OPER  POTENTIAL PROCESSED     QUEUED     QUEUED     SCHEDULED   SIMULATED                      OCC
  CODE     QTY       QTY          QTY        HRS         HRS         HRS        DESC   RCC       FAC
  ----  --------  --------   ---------  --------  ----------  -------- --     ----   ------    ----
 0000      73.       73.         73.        2.67       24.00       24.00     IN     MATPGB   1.00  BE05
 0010      73.       73.         12.       48.00        6.50       34.96     DIS    MATPGB   1.00  BE10
 0020      73.       73.          0.        0.00        0.00        0.00     KIT    MATPGB   1.00
 0030      73.       73.         75.     2954.98        8.00       36.02     ASSY   MATPGB   1.00  BE09,as
 0035 S    75.       75.          0.        0.00        2.00        5.26     INST   MATPGB   1.00
 0040      75.       75.          0.        0.00        2.75       22.46     TEST   MATPGB   1.00
 0050      75.       75.          1.       66.57        2.00        5.90     DIS    MATPGB   1.00  BK10,F-25
 0099      75.       75.          0.        0.00       24.00       24.00     OUT    MATPGB   1.00
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   32
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 ITEM NAME: GTE -180          WCD NAME: RWK180
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WCD by OPERATION STATISTIC AVERAGES
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                                                    AVERAGE    AVERAGE
 OPER   POTENTIAL PROCESSED   QUEUED    QUEUED     SCHEDULED  SIMULATED                  OCC
 CODE      QTY       QTY        QTY       HRS         HRS        HRS      DESC   RCC     FAC
 ----   --------  --------  ---------- --------  ----------  ----------   ----  ------  ----
 0000      20.       20.         0.       0.00      24.00       24.00     IN    MATPGB  1.00
 0010      20.       20.         7.      36.97       0.72        4.05     INSP  MATPGB  1.00  BE09
 0020      20.       20.         0.       0.00       2.72       29.75     DIS   MATPGB  1.00
 0030      20.       20.         0.       0.00      20.92      109.33     INSP  MATPGB  1.00
 0040 S    20.       20.         0.       0.00       2.72       21.62     INST  MATPGB  1.00
 0050      20.       20.         0.       0.00      13.93       49.88     TEST  MATPGB  1.00
 0060      20.       20.        12.      28.10       2.72        7.37     DIS   MATPGB  1.00  BK10,F-25
 9999      20.       20.         0.       0.00       2.00        2.00     TEST  MATPGB  1.00
ALC:  SA   RCC:  MATPGB  QUARTER:  4 DATE:  31-OCT-90  TIME:  11:57:13 REPT.ID: CUT 6    PAGE:   33
-------------------------------------------------------------------------------------------------

 ITEM NAME: GTE -397          WCD NAME: 13094A
WCD by OPERATION STATISTIC AVERAGES
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                                                    AVERAGE    AVERAGE
 OPER   POTENTIAL PROCESSED   QUEUED    QUEUED     SCHEDULED  SIMULATED                  OCC
 CODE      QTY       QTY        QTY       HRS         HRS        HRS      DESC   RCC     FAC
 ----   --------  --------  ---------- --------  ----------  ----------   ----  ------  ----
 0000     134.      134.       134.       2.91      24.00       24.00     IN    MATPGB  1.00  BE05
 0010     134.      134.        32.      47.67       6.50       33.70     DIS   MATPGB  1.00  BE10
 0020     134.      134.         0.       0.00       0.00        0.00     KIT   MATPGB  1.00
 0030     134.      134.       125.    3298.22       8.00       34.23     ASSY  MATPGB  1.00  BE09,as
 0035 S   125.      125.         0.       0.00       2.00        5.74     INST  MATPGB  1.00
 0040     125.      125.         0.       0.00       2.79       23.81     TEST  MATPGB  1.00
 0050     126.      126.         0.       0.00       2.00        7.47     DIS   MATPGB  1.00
 0099     126.      126.         0.       0.00      24.00       24.00     OUT   MATPGB  1.00
ALC:  SA   RCC:  MATPGB  QUARTER:  4 DATE:  31-OCT-90  TIME:  11:57:13 REPT.ID: CUT 6    PAGE:   34
-------------------------------------------------------------------------------------------------

 ITEM NAME: GTE -397          WCD NAME: RWK397
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WCD by OPERATION STATISTIC AVERAGES
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                                                     AVERAGE      AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED     QUEUED    SCHEDULED    SIMULATED                OCC
 CODE     QTY       QTY        QTY        HRS         HRS          HRS        DESC  RCC     FAC
 ----  --------- ---------  ---------- ---------  ----------  -----------    ----  ------  ----
0000      31.       31.          0.       0.00       24.00        24.00      IN    MATPGB  1.00
0010      31.       31.         11.      22.83        0.72         7.77      INSP  MATPGB  1.00  BE09
0020      31.       31.          0.       0.00        2.86        26.92      DIS   MATPGB  1.00
0030      30.       30.          0.       0.00       16.34        81.74      INSP  MATPGB  1.00
0040 S    30.       30.          0.       0.00        2.86        14.02      INST  MATPGB  1.00
0050      30.       30.          0.       0.00       17.41        77.85      TEST  MATPGB  1.00
0060      30.       30.         24.      24.13        2.86         5.34      DIS   MATPGB  1.00  BK10,F-25
9999      30.       30.          0.       0.00        2.00         2.00      TEST  MATPGB  1.00

ALC:   SA    RCC:   MATPGB   QUARTER:  4  DATE:   31-OCT-90  TIME:   11:57:13  REPT.ID: CUT 6      PAGE:   35
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 ITEM NAME: MATPSI 180 ONLY    WCD NAME: CLEAN

WCD by OPERATION STATISTIC AVERAGES
--------------------------------------
                                                     AVERAGE      AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED     QUEUED    SCHEDULED    SIMULATED                OCC
 CODE     QTY       QTY        QTY        HRS         HRS          HRS        DESC  RCC     FAC
 ----  --------- ---------  ---------- ---------  ----------  -----------    ----  ------  ----
0000      73.       73.          0.       0.00        8.00         8.51      IN    MATPSI  1.00
0010      73.       73.          0.       0.00       99.10       101.00      BS    MAEPNC  1.00
0020      73.       73.         64.      21.84       24.00       128.85      CLN   MATPSI  1.00  DO05
0099      74.       74.          0.       0.00        1.50         1.50      OUT   MATPSI  1.00

ALC:   SA    RCC:   MATPGB   QUARTER:  4  DATE:   31-OCT-90  TIME:   11:57:13  REPT.ID: CUT 6      PAGE:   36
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 ITEM NAME: MATPSI 180 ONLY    WCD NAME: INSPECT

WCD by OPERATION STATISTIC AVERAGES
--------------------------------------
                                                     AVERAGE      AVERAGE
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425

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```
 OPER  POTENTIAL PROCESSED    QUEUED    QUEUED  SCHEDULED   SIMULATED
 CODE     QTY       QTY        QTY       HRS       HRS        HRS       DESC   RCC    OCC
                                                                                      FAC
 ----  --------  --------  ---------- --------  ----------  ----------  ----  ------  ----
 0000     74.       74.         0.      0.00      24.00       24.00     IN    MATPSI  1.00
 0010     74.       74.        45.     60.64      60.18      369.91     INSP  MATPSI  1.00  DD09
 9999     76.       76.         0.      0.00      50.91       50.92     OUT   MATPSI  1.00

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:  37
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 ITEM NAME: MATPSI 397 ONLY    WCD NAME: CLEAN

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                     AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED    QUEUED    QUEUED    SCHEDULED   SIMULATED                   OCC
 CODE     QTY       QTY        QTY       HRS        HRS         HRS       DESC   RCC     FAC
 ----  --------  --------  ---------- --------  ----------  ----------  ----  ------  ----
 0000    134.      134.         1.      1.29       8.00       10.74     IN    MATPSI  1.00  DO05
 0010    134.      134.         0.      0.00     108.02      109.17     BS    MAEPNC  1.00
 0020    134.      134.       111.     21.18      24.00      128.59     CLN   MATPSI  1.00  DO05
 0099    134.      134.         0.      0.00       1.50        1.50     OUT   MATPSI  1.00

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGI :  38
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 ITEM NAME: MATPSI 397 ONLY    WCD NAME: INSPECT

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                     AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED    QUEUED    QUEUED    SCHEDULED   SIMULATED                   OCC
 CODE     QTY       QTY        QTY       HRS        HRS         HRS       DESC   RCC     FAC
 ----  --------  --------  ---------- --------  ----------  ----------  ----  ------  ----
 0000    134.      134.         0.      0.00      24.00       24.00     IN    MATPSI  1.00
 0010    134.      134.        77.     62.80      67.96      417.46     INSP  MATPSI  1.00  DD09
 9999    134.      134.         0.      0.00      44.52       44.55     OUT   MATPSI  1.00

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:  39
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#26

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H27

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ITEM NAME: TORUS TURBINE      WCD NAME: TG615D

WCD by OPERATION STATISTIC AVERAGES
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                                                         AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED     QUEUED     QUEUED   SCHEDULED   SIMULATED                 OCC
 CODE    QTY       QTY          QTY        HRS        HRS         HRS       DESC   RCC    FAC
 ----  --------  --------   ----------  --------  ----------  ----------   ----  ------  ----
 0100    73.       54.          0.        0.00      45.44       45.44      IN    MATPNN  0.75
 0140    73.       51.         32.       22.10       2.47        5.79      PROC  MATPNN  0.75  WK09
 0199    73.       56.          0.        0.00      32.83       32.83      OUT   MATPNN  0.75
 0200    73.       45.          0.        0.00      98.52      101.19      IN    MATPNC  0.60
 0240    74.       53.         42.       23.49       2.80        5.80      PROC  MATPNC  0.60  JA09,LATHE
 0299    74.       44.          0.        0.00      29.88       29.88      OUT   MATPNC  0.60
 0300    74.        7.          0.        0.00      36.78       36.78      IN    MATPNB  0.10
 0340    74.        7.          5.       17.98       0.21        0.21      PROC  MATPNB  0.10  DB09,FPI
 0399    74.        7.          0.        0.00      10.51       10.51      OUT   MATPNB  0.10
 0400    74.       69.          0.        0.00     116.27      117.24      IN    MATPNN  0.90
 0440    75.       65.         56.       18.44       0.50        0.50      PROC  MATPNN  0.90  WI09,WELDER
 0499    75.       70.          0.        0.00      31.60       31.60      OUT   MATPNN  0.90
 0500    75.       39.          0.        0.00      26.69       26.69      IN    MAEPDB  0.50
 0540    75.       37.         26.       18.73       0.21        0.69      PROC  MAEPDB  0.50  WJ09,OVEN(be)
 0599    76.       33.          0.        0.00      26.08       25.72      OUT   MAEPDB  0.50
 0600    75.       60.          0.        0.00      57.30       57.30      IN    MATPNN  0.80
 0640    75.       63.         50.       25.65       0.25        0.25      PROC  MATPNN  0.80  WI09,WELDER
 0699    76.       58.          0.        0.00      33.80       33.80      OUT   MATPNN  0.80
 0700    76.       32.          0.        0.00      69.77       69.77      IN    MATPNC  0.40
 0740    76.       26.         22.       21.07       2.80        2.80      PROC  MATPNC  0.40  JA09,RADLDR
 0799    75.       28.          0.        0.00      35.60       35.60      OUT   MATPNC  0.40
 0800    75.       14.          0.        0.00     271.84      271.84      IN    MATPNN  0.20
 0840    75.       20.         14.       20.44       0.25        0.25      PROC  MATPNN  0.20  WI09,WELDER
 0899    75.       17.          0.        0.00      38.33       38.33      OUT   MATPNN  0.20
 0900    75.       56.          0.        0.00     106.04      106.04      IN    MATPNB  0.80
 0940    75.       69.         51.       18.75       0.21        0.48      PROC  MATPNB  0.80  DB09,FPI
 0999    74.       54.          0.        0.00      35.21       35.21      OUT   MATPNB  0.80
 1000    74.       42.          0.        0.00     300.12      300.12      IN    MATPNC  0.50
 1040    74.       42.         32.       20.70       2.80        5.70      PROC  MATPNC  0.50  JA09
 1099    74.       37.          0.        0.00      39.85       39.85      OUT   MATPNC  0.50
 1100    74.       54.          0.        0.00      98.93       98.93      IN    MATPNN  0.75
 1140    74.       56.         50.       19.18       0.25        0.25      PROC  MATPNN  0.75  WI09
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1199      74.     56.        0.      0.00     28.59       28.59     OUT   MATPNN  0.75
1200      74.     55.        0.      0.00    113.25      113.25     IN    MATPNB  0.65
1240      74.     44.       34.     22.53      0.21        0.21     PROC  MATPNB  0.65  DB09,FPI
1299      74.     48.        0.      0.00     34.09       34.09     IN    MATPNB  0.65
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6      PAGE:   40
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 ITEM NAME: TURBINE BRG. HSG.  WCD NAME: TG847F

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                  AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED    QUEUED    QUEUED   SCHEDULED   SIMULATED                  OCC
 CODE     QTY       QTY         QTY       HRS       HRS         HRS      DESC  RCC      FAC
 ----  --------  --------  ---------- --------  ----------  ----------  ----  ------   ----
0100     134.      56.         0.      0.00     196.84      196.84     IN    MATPNC   0.35
0140     134.      50.        18.     17.93       0.18        0.55     PROC  MATPNC   0.35  JA09
0199     134.      54.         0.      0.00      31.21       31.21     OUT   MATPNC   0.35
0200     134.      12.         0.      0.00     630.82      630.82     IN    MAEIAA   0.09
0240     134.      11.         7.     27.12       0.95        0.95     PROC  MAEIAA   0.09  UA09,STRPTNK(be
0299     134.      10.         0.      0.00      38.29       38.29     OUT   MAEIAA   0.09
0300     134.       8.         0.      0.00     404.36      404.36     IN    MATPNC   0.06
0340     134.      15.         6.     25.85       1.00        1.00     PROC  MATPNC   0.06  JA09,LATHE
0399     134.      10.         0.      0.00      30.48       30.48     OUT   MATPNC   0.06
0400     134.      35.         0.      0.00     290.58      290.58     IN    MATPNB   0.21
0440     134.      25.        18.     25.88       0.21        0.21     PROC  MATPNB   0.21  DB09,FPI
0499     134.      28.         0.      0.00      28.17       28.17     OUT   MATPNB   0.21
0500     134.      21.         0.      0.00     494.47      494.47     IN    MAEPDB   0.15
0540     134.      13.         5.     14.46       0.75        0.75     PROC  MAEPDB   0.15  WJ09
0599     134.      20.         0.      0.00      34.54       34.54     OUT   MAEPDB   0.15
0600     134.      15.         0.      0.00    1011.06     1345.46     IN    MAEIAA   0.15
0640     136.      20.        11.     12.79       1.15        4.48     PROC  MAEIAA   0.15  UA09,CHRMTNK(be
0699     136.      16.         0.      0.00      25.85       25.85     OUT   MAEIAA   0.15
0700     136.      21.         0.      0.00     188.84      223.27     IN    MATPNN   0.18
0740     137.      26.        15.     18.59       1.27        3.83     PROC  MATPNN   0.18  WK09
0799     137.      21.         0.      0.00      39.45       39.45     OUT   MATPNN   0.18
0800     137.      22.         0.      0.00     813.73      813.73     IN    MATPNC   0.21
0840     137.      27.        16.     20.42       1.00        2.36     PROC  MATPNC   0.21  JA09,LATHE
0899     137.      31.         0.      0.00      38.91       38.91     OUT   MATPNC   0.21
0900     137.      41.         0.      0.00     446.64      446.64     IN    MATPNB   0.35
0940     137.      35.        25.     14.90       0.21        0.21     PROC  MATPNB   0.35  DB09,FPI
```

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681

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0999    138.     57.        0.      0.00     30.05      30.05    OUT   MATPNB   0.35
1000    138.    122.        0.      0.00   1780.11    1327.04    IN    MATPMM   0.85
1040    126.    107.       89.     19.64      0.33       0.51    PROC  MATPMM   0.85  PT05,BOOTH(be)
1099    126.    105.        0.      0.00     32.95      32.95    OUT   MATPMM   0.85

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   41
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 ITEM NAME: TURBINE NOZZLE 180 WCD NAME: TG618D

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                      AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED    QUEUED    QUEUED     SCHEDULED   SIMULATED                  OCC
 CODE     QTY       QTY         QTY       HRS          HRS         HRS     DESC   RCC     FAC
 ----  --------  --------  ----------  --------  ----------  ----------   ----  ------  ----
0100      73.       60.         0.       0.00      535.64      526.29     IN    MAEIAA  0.77
0140      73.       59.        42.      20.15        0.30        0.30     PROC  MAEIAA  0.77  UA09,STRIP(be)
0199      74.       55.         0.       0.00       32.40       32.40     OUT   MAEIAA  0.77
0200      74.       52.         0.       0.00     1179.29     1172.27     IN    MATPNC  0.77
0240      75.       60.        43.      21.38        2.10        3.63     PROC  MATPNC  0.77  JA09,LATHE
0299      75.       55.         0.       0.00       31.95       31.95     OUT   MATPNC  0.77
0300      75.       65.         0.       0.00      329.72      388.68     IN    MATPNB  0.85
0340      77.       66.        54.      21.04        0.21        1.51     PROC  MATPNB  0.85  DB09,FPI
0399      76.       64.         0.       0.00       35.69       35.69     OUT   MATPNB  0.85
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   42
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 ITEM NAME: TURBINE NOZZLE 397 WCD NAME: TA841F

WCD by OPERATION STATISTIC AVERAGES
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                                                      AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED    QUEUED    QUEUED     SCHEDULED   SIMULATED                  OCC
 CODE     QTY       QTY         QTY       HRS          HRS         HRS     DESC   RCC     FAC
 ----  --------  --------  ----------  --------  ----------  ----------   ----  ------  ----
0100     134.       35.         0.       0.00     1966.29     1715.92     IN    MAEIAA  0.17
0140     132.       21.         6.      21.23        0.24        0.24     PROC  MAEIAA  0.17  UA09,STRIP(be)
0199     132.       27.         0.       0.00       32.28       32.28     OUT   MAEIAA  0.17
0200     132.       71.         0.       0.00      561.26      522.37     IN    MATPNC  0.48
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 0240     131.      56.        34.     18.47      5.97       32.07     PROC  MATPNC  0.48  JA09,RADLDR
 0299     131.      62.         0.      0.00     33.61       33.61     OUT   MATPNC  0.48
 0300     131.      72.         0.      0.00   1758.63     1789.15     IN    MAEIAA  0.48
 0340     128.      61.        46.     18.34      4.00       12.81     PROC  MAEIAA  0.48  UA09,FIC(be)
 0399     128.      67.         0.      0.00     37.44       37.44     OUT   MAEIAA  0.48
 0400     128.      65.         0.      0.00    988.33      920.18     IN    MAEPDB  0.45
 0440     126.      54.        34.     16.71      0.31        0.65     PROC  MAEPDB  0.45  WJ09,OVEN(be)
 0499     126.      56.         0.      0.00     32.41       32.41     OUT   MAEPDB  0.45
 0500     126.      41.         0.      0.00    231.76      211.48     IN    MATPNC  0.34
 0540     123.      46.        35.     21.39      0.10        0.10     PROC  MATPNC  0.34  JA09,LATHE
 0599     123.      28.         0.      0.00     36.87       36.87     OUT   MATPNC  0.34

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:   43
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 ITEM NAME: WHEEL&SHAFTASSY.   WCD NAME: TG645D

WCD by OPERATION STATISTIC AVERAGES
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                                                  AVERAGE     AVERAGE
  OPER  POTENTIAL PROCESSED    QUEUED    QUEUED  SCHEDULED   SIMULATED                    OCC
  CODE     QTY       QTY         QTY       HRS      HRS         HRS      DESC   RCC       FAC
  ----  --------  --------   ---------  --------  ----------  ----------  ----  ------    ----
 0100      73.       73.         0.      0.00    647.31      622.29     IN    MATPNC  1.00
 0140      75.       75.        66.     26.43      1.13        1.38     PROC  MATPNC  1.00  JA09,GRINDER
 0199      75.       75.         0.      0.00     31.62       31.62     OUT   MATPNC  1.00
 0200      75.       53.         0.      0.00    187.65      187.65     IN    MATPNB  0.80
 0240      75.       65.        51.     14.45      0.21        0.21     PROC  MATPNB  0.80  DB09,FPI
 0299      76.       61.         0.      0.00     37.98       37.98     OUT   MATPNB  0.80
 0300      76.       57.         0.      0.00     74.84       74.84     IN    MATPNN  0.80
 0340      76.       61.        46.     19.21      1.25        1.55     PROC  MATPNN  0.80  WI09
 0399      76.       63.         0.      0.00     32.07       32.07     OUT   MATPNN  0.80
 0400      76.       57.         0.      0.00    346.84      338.51     IN    MATPNC  0.80
 0440      75.       58.        48.     20.21      1.28        2.43     PROC  MATPNC  0.80  JA09,GRINDER
 0499      75.       66.         0.      0.00     33.81       33.81     OUT   MATPNC  0.80
 0500      75.        1.         0.      0.00     10.51       10.51     IN    MAEPDB  0.01
 0540      75.        2.         1.      3.58      1.33        1.33     PROC  MAEPDB  0.01  WJ09
 0599      75.        0.         0.      0.00      0.00        0.00     OUT   MAEPDB  0.01
 0600      75.       75.         0.      0.00     81.57       81.57     IN    MATPNB  1.00
 0640      75.       75.        60.     20.07      0.21        1.10     PROC  MATPNB  1.00  DB09,FPI
 0699      75.       75.         0.      0.00     32.35       32.35     OUT   MATPNB  1.00
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0700     75.     75.      0.     0.00   133.55   133.55   IN     MATPNC   1.00
0740     75.     75.     67.    18.93     0.14     0.14   PROC   MATPNC   1.00   JA09,GRINDER
0799     75.     75.      0.     0.00    30.37    30.37   OUT    MATPNC   1.00
0800     75.     75.      0.     0.00   244.54   240.79   IN     MATPGB   1.00
0840     74.     74.     63.    18.61     0.58     2.00   PROC   MATPGB   1.00   KH09,BALANCER
0899     74.     74.      0.     0.00    37.59    37.59   OUT    MATPGB   1.00

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6    PAGE:   44
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BACKSHOP DWELL TIMES BY BACKSHOP RCC
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                                       AVERAGE
ITEM                         RCC        HOURS
------------------        --------    -------
1ST.STG.COMPR.DIFF        MATPNC       488.97
1ST.STG.COMPR.DIFF        MATPNB       133.77
1ST.STG.COMPR.DIFF        MAEIAA       259.84

1ST.STG.INLETASSY.        MATPNC       831.45
1ST.STG.INLETASSY.        MATPNB       201.22
1ST.STG.INLETASSY.        MAEIAA       230.33
1ST.STG.INLETASSY.        MATPNN       153.98

2ND.STG.COMPR.DIFF        MATPNC       701.76
2ND.STG.COMPR.DIFF        MATPNN        59.39
2ND.STG.COMPR.DIFF        MATPNB       121.57
2ND.STG.COMPR.DIFF        MAEIAA       949.73

2ND.STG.DIFF.ASSY         MATPNC      1879.50
2ND.STG.DIFF.ASSY         MATPNB       314.88
2ND.STG.DIFF.ASSY         MATPNN       299.43
2ND.STG.DIFF.ASSY         MAEPDB        30.32
2ND.STG.DIFF.ASSY         MATPMM       573.97

2ND.STG.DIFF.HSG.         MATPNC      1497.01
2ND.STG.DIFF.HSG.         MAEIAA       328.74
2ND.STG.DIFF.HSG.         MATPNN       349.19
2ND.STG.DIFF.HSG.         MATPNB        30.10
2ND.STG.DIFF.HSG.         MATPMM        21.72
```

431-A

684

#31-B

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2NDSTG.COMPR.HSG.           MATPNC     1109.32
2NDSTG.COMPR.HSG.           MATPNB      274.00
2NDSTG.COMPR.HSG.           MAEIAA      303.47
2NDSTG.COMPR.HSG.           MATPNN      365.52

ACCESSORY CASE              MATPNC      154.61
ACCESSORY CASE              MATPNN        0.52
ACCESSORY CASE              MATPNB       91.61
ACCESSORY CASE              MAEPDB        0.32
ACCESSORY CASE              MATPSI       39.84
ACCESSORY CASE              MATPMM       81.92

BACKSHOP 180           *** NO BACKSHOP ACTIVITY *****

BACKSHOP 397           *** NO BACKSHOP ACTIVITY *****

BEARING HSG.                MATPNC     1649.35
BEARING HSG.                MATPNB     1004.02
BEARING HSG.                MATPNN       71.49
BEARING HSG.                MAEIAA        0.15

COMB. CHAMBER LNG.          MATPNN      278.93
COMB. CHAMBER LNG.          MATPNC       97.58

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:  45
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BACKSHOP DWELL TIMES BY BACKSHOP RCC
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                                       AVERAGE
ITEM                          RCC       HOURS
------------------         ---------   -------
COMB. CHAMBER LNG.          MATPNB       69.65
COMB. CHAMBER LNG.          MAEPDB       17.97
COMB. CHAMBER LNG.          MAEPCA      114.79

COMPRESSOR INLET            MATPNC      685.32
COMPRESSOR INLET            MATPNN       11.89
COMPRESSOR INLET            MATPNB       75.52
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#32

686

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COMPRESSOR INLET          MAEIAA      806.54

GTE -180                  MATPGB       26.00

GTE -397                  MATPGB       26.00

MATPSI 180 ONLY       *** NO BACKSHOP ACTIVITY *****

MATPSI 397 ONLY       *** NO BACKSHOP ACTIVITY *****

TORUS TURBINE             MATPNN      422.50
TORUS TURBINE             MATPNC      313.08
TORUS TURBINE             MATPNB      215.62
TORUS TURBINE             MAEPDB       25.04

TURBINE BRG. HSG.         MATPNC      260.73
TURBINE BRG. HSG.         MAEIAA      213.00
TURBINE BRG. HSG.         MATPNB      227.86
TURBINE BRG. HSG.         MAEPDB       82.65
TURBINE BRG. HSG.         MATPNN       40.52
TURBINE BRG. HSG.         MATPMM     1200.64

TURBINE NOZZLE 180        MAEIAA      456.65
TURBINE NOZZLE 180        MATPNC      847.19
TURBINE NOZZLE 180        MATPNB      366.91

TURBINE NOZZLE 397        MAEIAA     1457.74
TURBINE NOZZLE 397        MATPNC      374.09
TURBINE NOZZLE 397        MAEPDB      481.68

WHEEL&SHAFTASSY.          MATPNC     1101.46
WHEEL&SHAFTASSY.          MATPNB      277.02
WHEEL&SHAFTASSY.          MATPNN       82.71
WHEEL&SHAFTASSY.          MAEPDB        0.14
WHEEL&SHAFTASSY.          MATPGB      278.38

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:  46
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HISTORICAL vs. SIMULATED COMPARISON
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                      HISTORICAL VALUES                      SIMULATED VALUES
                    FLOWTIME    STANDARD   SAMPLE     FLOWTIME    STANDARD   SAMPLE    WORKLOAD   PERCENTAGE
  ITEM                HOURS    DEVIATION    SIZE        HOURS    DEVIATION    SIZE      WEIGHT    DIFFERENCE
 ----------------  --------------------------------   --------------------------------  --------   ----------
 1ST.STG.COMPR.DIFF   969.60        0.00       0        912.19      444.51      73       0.000          5.92
 1ST.STG.INLETASSY.  1536.00        0.00       0       1429.27      812.19      72       0.000          6.95
 2ND.STG.COMPR.DIFF  1795.20        0.00       0       1851.15     1260.46      78       0.000          3.12
 2ND.STG.DIFF.ASSY   3240.00        0.00       0       3263.11     1206.28     128       0.000          0.71
 2ND.STG.DIFF.HSG.   2059.20        0.00       0       2255.90     1591.77      75       0.000          9.55
 2NDSTG.COMPR.HSG.   2289.60        0.00       0       2157.27     1135.17      72       0.000          5.78
 ACCESSORY CASE       427.44        0.00       0        416.20      203.72     134       0.000          2.63
 BACKSHOP 180        1200.00        0.00       0       1189.18      434.81      75       0.000          0.90
 BACKSHOP 397         720.00        0.00       0        704.04      620.68     132       0.000          2.22
 BEARING HSG.        2714.40        0.00       0       2943.39     2137.77      79       0.000          8.44
 COMB. CHAMBER LNG.   686.88        0.00       0        730.46      160.34      75       0.000          6.34
 COMPRESSOR INLET    1644.00        0.00       0       1584.77     1190.96     132       0.000          3.60
 GTE -180               0.00        0.00       0       3192.32      522.34      75       0.000          0.00
 GTE -397               0.00        0.00       0       3529.08      345.08     125       0.000          0.00
 MATPSI 180 ONLY        0.00        0.00       0        736.97      144.91      76       0.000          0.00
 MATPSI 397 ONLY        0.00        0.00       0        789.65      152.26     134       0.000          0.00
 TORUS TURBINE        984.00        0.00       0       1100.19      358.38      74       0.000         11.81
 TURBINE BRG. HSG.   2496.00        0.00       0       2100.99     1531.92     126       0.000         15.83
 TURBINE NOZZLE 180  1768.80        0.00       0       1704.35     1132.01      76       0.000          3.64
 TURBINE NOZZLE 397  1896.00        0.00       0       2111.01     2062.86     123       0.000         11.34
 WHEEL&SHAFTASSY.    1617.60        0.00       0       1895.23      852.35      74       0.000         17.16

 ITEM 1ST.STG.COMPR.DIFF EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

 ITEM 1ST.STG.INLETASSY. EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

 ITEM 2ND.STG.COMPR.DIFF EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

 ITEM 2ND.STG.DIFF.ASSY  EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

 ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6      PAGE:    47
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 HISTORICAL vs. SIMULATED COMPARISON
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 ITEM 2ND.STG.DIFF.HSG.  EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
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ITEM 2NDSTG.COMPR.HSG.  EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM ACCESSORY CASE     EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM BACKSHOP 180       EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM BACKSHOP 397       EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM BEARING HSG.       EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM COMB. CHAMBER LNG. EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM COMPRESSOR INLET   EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM GTE -180           EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM GTE -397           EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM MATPSI 180 ONLY    EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM MATPSI 397 ONLY    EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM TORUS TURBINE      EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM TURBINE BRG. HSG.  EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM TURBINE NOZZLE 180 EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  31-OCT-90  TIME:  11:57:13  REPT.ID: CUT 6     PAGE:   48
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HISTORICAL vs. SIMULATED COMPARISON
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ITEM TURBINE NOZZLE 397 EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
ITEM WHEEL&SHAFTASSY.   EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA
NOT ENOUGH ITEMS REMAINING TO CONDUCT VALIDATION TEST
```

#34

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ENGINEERING NOTES

EMPLOYEE Parker DATE 11/1/90 PAGE NO. 134
RCC All SUBJECT Experimentation

11/1/90 -

Scott, Ken, and I discussed various considerations for the GTE experimentation efforts which we are trying to format at this time. The IPI Experimentation sheet, which follows, was provided by Mr. Gonzales. We agree that most of the items on this sheet represent valid experimentation candidates. The only one we would have real difficulty is item #6, which entails reducing the Sub/Final assy. rejection rate. This data, in a format that could be manipulated in such a matter, is not in the model as such. Rather, we decided to model rejects at the GTE end item level, as we had more "hard" data available to us for that analysis (as previously discussed in my engr. notes). The only data which we have concerning rejects at subassembly or final assembly is an informal log book which was provided by Mr. Samora. This log details the rejection of individual components at the GTE build-up stations. While the log does not provide any details on the amount of labor or lost hours attributed to these defective parts, it does provide the historic occurrence of these items' rejection rate. I would suggest that we delete this item from our list of possible experimentation candidates, and analyze the log data in detail along with the other rejection data which we are including in our engineering assessment.

The other points of discussion involved the relatively high utilization of the inspection personnel in MATPSI. These personnel were utilized at a rate of 72% for the WG09s and 53% for the WG10s. Please note on the attached information sheet showing the inductions of all Gas Turbine Engines over the past three years, the -180 and -397 engines have made up a significant part of the GTE workload. The FY 90 data indicates that these two engines combined make up 49% of the entire workload for this year. Also, the data used in constructing the model was taken from our parts tracking efforts, and is considered to be of exceptionally high quality. For these reasons, we feel that the reported utilization of the inspection personnel is reasonably accurate (personnel assigned to

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ENGINEERING NOTES

EMPLOYEE Parker DATE 11/1 PAGE NO. 135
RCC A11 SUBJECT Experimentation

starter workloads only are not present in the "total manpower available" entry for this model).

The other items on the the list are considered excellent experimentation candidates. (Mr. Gonzales did a good job constructing this list. It is well thought out). We are going to discuss the actual construction of our experimental array with Mr. Gardner tomorrow morning.

Also attached is the results of the GTE model ran at different seeds. As can easily be seen, the model is very robust in its response to these different seed runs (i.e., little change).

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IPI EXPERIMENTATION

1) Reduce WIP. What effect would a reduction in WIP cause on throughput?

   ↓ [illegible] > a. Accelerate WIP and analyze the effect on production.

   ↑ [illegible] > b. Increase WIP and analyze the effect on production.

   c. For Phil: calculate WIP($ amount)

2) Reduce manpower by 5, 10, 15, and 20%.

   a. What adverse effect does this have on throughput?

   b. What adverse effect does this have on flowtime?

3) Simulate Surge Conditions.

   a. Increase GTE demand by 25, 50, 75, 100%.

   [illegible] > b. Increase # of shifts(PSI, PGB, PNC)

4) How will the Short Stack tranfer to B329 effect throughput?

5) Reduce the GTE rejection rate.

   a. Reduce GTE rejection rates in 2% increments and analyze the effect on production.

6) Reduce the Sub/Final assembly rejection rate.

   a. Reduce machine shop rejected items in 2% increments and analyze its effect on production.

7) GTE Inductions.

   a. Vary the GTE induction rate : - constant inductions
   - once a month

* A detailed analysis of each experimentation run and associated savings is required.

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GAS TURBINE ENGINES

		FY 88			FY 89			FY 90	
ASSETS	Total ASSETS INDUCTED	LABOR STD HR	TOTAL TIME HRS	Total ASSETS INDUCTED	LABOR STD HR	TOTAL TIME HRS	Total ASSETS INDUCTED	LABOR STD HR	TOTAL TIME HRS
T41M9	36	5	180.00	51	5	255.00	16	5	80.00
85-71	99	4.22	417.78	106	4.22	447.32	41	4.22	173.02
85-106	27	5.57	150.39	129	5.57	718.53	34	5.57	189.38
85-180L	125	6.33	791.25	207	6.33	1310.31	103	6.33	651.99
85-165	22	4.09	89.98	53	4.09	216.77	7	4.09	28.63
36-50	45	8	360.00	73	8	584.00	56	8	448.00
85-56	20	4.22	84.40	46	4.22	194.12	32	4.22	135.04
85-72	98	4.22	413.56	140	4.22	590.80	140	4.22	590.80
85-116	4	4.22	16.88	0	4.22	0.00	7	4.22	29.54
85-70	70	4.22	295.40	77	4.22	324.94	39	4.22	164.58
85-397	148	5.67	839.16	292	5.67	1655.64	260	5.67	1474.20
	694.00		3638.80	1174.00		6297.43	735.00		3965.18
180/397 ÷ All =	39%	of the workload			43%			49%	

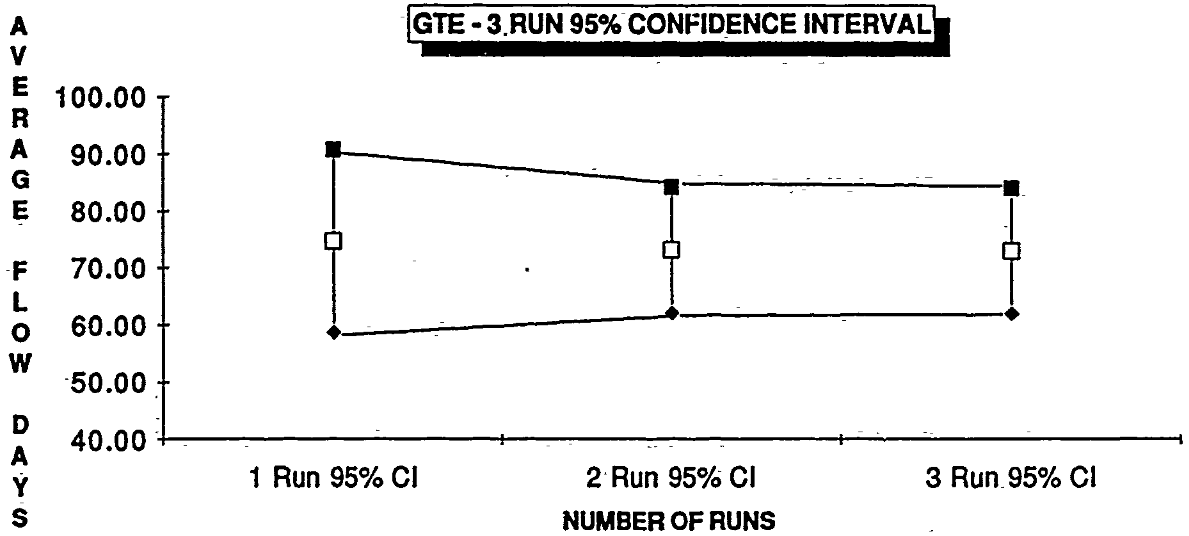
161926.6
280235.635
176450.51

ASSETS	TOTAL ASSETS INDUCTED	LABOR STD HR	TIME HRS	TOTAL ASSETS INDUCTED	LABOR STD HR	TIME HRS	TOTAL ASSETS INDUCTED	LABOR STD HR	TIME HRS
CPS 01	6		0	6		0	6		0
CPS 02M	366	1.3	475.8	477	1.3	620.1	62	1.3	80.6
CPS 07	9	1.38	12.42	27	1.38	37.26	16	1.38	22.08
CPS 09	188	2.75	517	495	2.75	1361.25	98	2.75	269.5
CPS 11	78	2.18	170.04	212	2.18	462.16	86	2.18	187.48
CPS 12	3			4			0		
100-87	175	2.93	512.75	147	2.93	430.71	11	2.93	32.23
100-89	327	1.9	621.3	434	1.9	824.6	176	1.9	334.4
100-97	113	2.52	284.76	310	2.52	781.2	8	2.52	20.16
100-97A	30	2.52	75.6	93	2.52	234.36	116	2.52	292.32
100-176	12	1.64	19.68	37	1.64	60.68	8	1.64	13.12
100-138	110	1.19	130.9	286	1.19	340.34	155	1.19	194.45
100-176A	20	1.64	32.8	36	1.64	59.04	4	1.64	6.56
100-302	50		0	88		0	15		0
100-325	56	2.08	116.48	107	2.08	222.56	12	2.08	24.96
100-421	18	1.44	25.92	140	1.44	201.6	79	1.44	113.76
100-422	43	2.31	99.33	220	2.31	508.2	0	2.31	0
100-395	115	2.7	310.5	113	2.7	305.1		2.7	
	1719		3405.28	3232		6449.16	852		1591.62

151534.96
70382.09
286987.62

88 total 438

5,546 hrs


GTE - 3 RUN 95% CONFIDENCE INTERVAL
AVERAGE FLOW DAYS
100.00
90.00
80.00
70.00
60.00
50.00
40.00
1 Run 95% CI
2 Run 95% CI
3 Run 95% CI
NUMBER OF RUNS

GTE VALIDATION 3 RUN AVERAGE

ITEM NAME	HISTORICAL FLOW DAYS	SIMULATED FLOW DAYS	% DIFF		NUMBER OUTPUT	NUMBER INPUT	% DIFF
1ST.STG.COMPR.DIFF	40	38	-7		73	73	0
1ST.STG.INLETASSY.	64	63	-1		73	73	-1
2ND.STG.COMPR.DIFF	75	76	1		77	73	-6
2ND.STG.DIFF.ASSY	135	138	2		133	134	1
2ND.STG.DIFF.HSG.	86	88	2		73	73	0
2NDSTG.COMPR.HSG.	95	95	0		77	73	-6
ACCESSORY CASE	18	18	2		134	134	0
BACKSHOP 180	50	52	4		73	73	0
BACKSHOP 397	30	30	2		132	134	2
BEARING HSG.	113	116	3		78	73	-7
COMB. CHAMBER LNG.	29	30	4		73	73	-1
COMPRESSOR INLET	69	67	-3		133	134	1
GTE -180	0	129			76	73	-4
GTE -397	0	151			131	134	2
MATPSI 180 ONLY	0	31			74	73	-1
MATPSI 397 ONLY	0	32			134	134	0
TORUS TURBINE	41	44	6		73	73	-1
TURBINE BRG. HSG.	104	99	-5		133	134	1
TURBINE NOZZLE 180	74	71	-4		73	73	0
TURBINE NOZZLE 397	79	82	3		131	134	2
WHEEL&SHAFTASSY.	67	81	17	**	73	73	0

1,2 and 3 RUN 95 CONFIDENCE INTERVAL

1 Run

Average	St Dev
74.63	39.30

** balancing time was added to the model that what not included in historical time

2 Run

Average	St Dev
73.01	38.21

3 Run

Average	St Dev
72.88	38.01

	1 Run 95% CI	2 Run 95% CI	3 Run 95% C.I.
Upper Limit	90.69	84.05	83.86
Mean	74.63	73.01	72.88
Lower Limit	58.56	61.97	61.89

GTE VALIDATION RUN SUMMARY - SEED 1

GTEVAL1.SPR

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN
1ST.STG.COMPR.DIFF	890.88	485.78	73	72
1ST.STG.INLETASSY.	1633.79	956.09	76	72
2ND.STG.COMPR.DIFF	2002.38	1514.57	78	72
2ND.STG.DIFF.ASSY	3373.61	1161.28	135	134
2ND.STG.DIFF.HSG.	2082.51	1530.68	71	72
2NDSTG.COMPR.HSG.	2258.66	1135.68	75	72
ACCESSORY CASE	442.53	208.2	134	134
BACKSHOP 180	1276.16	446.45	72	72
BACKSHOP 397	723.27	769.59	130	134
BEARING HSG.	2865.57	1950.47	81	72
COMB. CHAMBER LNG.	719.39	194.91	73	72
COMPRESSOR INLET	1749.34	1078.82	135	134
GTE -180	3123.51	682.5	80	73
GTE -397	3653.91	395.72	133	134
MATPSI 180 ONLY	754.29	149.37	73	72
MATPSI 397 ONLY	781.84	157.29	134	134
TORUS TURBINE	1078.7	451.37	74	72
TURBINE BRG. HSG.	2619.12	1968.7	140	134
TURBINE NOZZLE 180	1743.47	1292.59	74	72
TURBINE NOZZLE 397	1841.59	1889.67	134	134
WHEEL&SHAFTASSY.	1997.82	825.18	70	72

GTE VALIDATION RUN SUMMARY - SEED 2

GTEVAL2.SPR

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN
1ST.STG.COMPR.DIFF	902.85	377.31	73	73
1ST.STG.INLETASSY.	1484.59	847.25	72	73
2ND.STG.COMPR.DIFF	1602.87	1245.19	75	73
2ND.STG.DIFF.ASSY	3320.18	1494.12	136	134
2ND.STG.DIFF.HSG.	1973.12	1212.67	72	73
2NDSTG.COMPR.HSG.	2424.61	1262.79	84	73
ACCESSORY CASE	450.97	204.05	134	134
BACKSHOP 180	1303.6	430.6	72	73
BACKSHOP 397	766.19	708.75	133	134
BEARING HSG.	2560.57	1618.38	73	73
COMB. CHAMBER LNG.	706.65	168.89	72	73
COMPRESSOR INLET	1467.2	951.61	131	134
GTE -180	2938.81	516.1	72	73
GTE -397	3663.35	465.74	135	134
MATPSI 180 ONLY	749.68	151.99	72	73
MATPSI 397 ONLY	742.08	147.2	134	134
TORUS TURBINE	974.95	319.08	72	73
TURBINE BRG. HSG.	2401.27	1926.81	133	134
TURBINE NOZZLE 180	1667.97	1260.2	69	73
TURBINE NOZZLE 397	1916.06	1839.44	135	134
WHEEL&SHAFTASSY.	1964.45	790.96	74	73

GTE VALIDATION RUN SUMMARY - SEED 3

GTEVAL3.SPR

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN
1ST.STG.COMPR.DIFF	912.19	444.51	73	73
1ST.STG.INLETASSY.	1429.27	812.19	72	73
2ND.STG.COMPR.DIFF	1851.15	1260.46	78	73
2ND.STG.DIFF.ASSY	3263.11	1206.28	128	134
2ND.STG.DIFF.HSG.	2255.9	1591.77	75	73
2NDSTG.COMPR.HSG.	2157.27	1135.17	72	73
ACCESSORY CASE	416.2	203.72	134	134
BACKSHOP 180	1189.18	434.81	75	73
BACKSHOP 397	704.04	620.68	132	134
BEARING HSG.	2943.39	2137.77	79	73
COMB. CHAMBER LNG.	730.46	160.34	75	73
COMPRESSOR INLET	1584.77	1190.96	132	134
GTE -180	3192.32	522.34	75	73
GTE -397	3529.08	345.08	125	134
MATPSI 180 ONLY	736.97	144.91	76	73
MATPSI 397 ONLY	789.65	152.26	134	134
TORUS TURBINE	1100.19	358.38	74	73
TURBINE BRG. HSG.	2100.99	1531.92	126	134
TURBINE NOZZLE 180	1704.35	1132.01	76	73
TURBINE NOZZLE 397	2111.01	2062.86	123	134
WHEEL&SHAFTASSY.	1895.23	852.35	74	73

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ENGINEERING NOTES

EMPLOYEE Parker DATE 11/2/90 PAGE NO. 136
RCC All SUBJECT Experimentation

11/2/90 -

We turned in our suggestions regarding experimentation to Mr. Gardner yesterday afternoon. He has examined the data, and the following are his suggestions for the structuring of our experimentation data into the proper Taguchi format:

INNER ARRAY
$L_9(3^4)$

Factor	Levels		
	1	2	3
1) Manpower	As Is	-10%	-20%
2) Surge (Workload)	As Is	+50%	+100%
3) Reject Rate	As Is	-10%	-30%
4) WIP	As Is	+10%*	+30%*

* Indicates percentage increase of floating stock.

OUTER ARRAY
$L_4(2^3)$

Factor	Levels	
	1	2
1) Short Stack	As Is	Transfer to Bld 329
2) Inductions	As Is	Once a month
3) Interaction 1x2	1	2

Nine runs x four runs = 36 x two seeds = 72 runs total
(excluding confirmation runs)

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GTE $L_9^{L_4}$

Exp #	Short Stack	Inductions	Manpower	Workload	Reject rate	WIP
1) 1,1	As Is	As Is	As Is	As Is	As Is	As Is
2) 2,1	As Is	As Is	As Is	+50%	-10%	+10%FS
3) 3,1	As Is	As Is	As Is	+100%	-30%	+30%FS
4) 4,1	As Is	As Is	-10%	As Is	-10%	+30%
5) 5,1	As Is	As Is	-10%	+50%	-30%	As Is
6) 6,1	As Is	As Is	-10%	+100%	As Is	+10%
7) 7,1	As Is	As Is	-20%	As Is	-30%	+10%
8) 8,1	As Is	As Is	-20%	+50%	As Is	+30%
9) 9,1	As Is	As Is	-20%	+100%	-10%	As Is
10) 1,2	As Is	Monthly	As Is	As Is	As Is	As Is
11) 2,2	As Is	Monthly	As Is	+50%	-10%	+10%
12) 3,2	As Is	Monthly	As Is	+100%	-30%	+30%
13) 4,2	As Is	Monthly	-10%	As Is	-10%	+30%
14) 5,2	As Is	Monthly	-10%	+50%	-30%	As Is
15) 6,2	As Is	Monthly	-10%	+100%	As Is	+10%
16) 7,2	As Is	Monthly	-20%	As Is	-30%	+10%
17) 8,2	As Is	Monthly	-20%	+50%	As Is	+30%
18) 9,2	As Is	Monthly	-20%	+100%	-10%	As Is

445

6

GTE $L_9 {}^{L_4}$

Exp #	Short Stack	Inductions	Manpower	Workload	Reject rate	WIP
19) 1,3	B329	As Is	As Is	As Is	As Is	As Is
20) 2,3	B329	As Is	As Is	+50%	-10%	+10%
21) 3,3	B329	As Is	As Is	+100%	-30%	+30%
22) 4,3	B329	As Is	-10%	As Is	-10%	+30%
23) 5,3	B329	As Is	-10%	+50%	-30%	As Is
24) 6,3	B329	As Is	-10%	+100%	As Is	+10%
25) 7,3	B329	As Is	-20%	As Is	-30%	+10%
26) 8,3	B329	As Is	-20%	+50%	As Is	+30%
27) 9,3	B329	As Is	-20%	+100%	-10%	As Is
28) 1,4	B329	Monthly	As Is	As Is	As Is	As Is
29) 2,4	B329	Monthly	As Is	+50%	-10%	+10%
30) 3,4	B329	Monthly	As Is	+100%	-30%	+30%
31) 4,4	B329	Monthly	-10%	As Is	-10%	+30%
32) 5,4	B329	Monthly	-10%	+50%	-30%	As Is
33) 6,4	B329	Monthly	-10%	+100%	As Is	+10%
34) 7,4	B329	Monthly	-20%	As Is	-30%	+10%
35) 8,4	B329	Monthly	-20%	+50%	As Is	+30%
36) 9,4	B329	Monthly	-20%	+100%	-10%	As Is

446

700

Wcd	Item Name	
13094A	GTE -397	ODCcde: CD

Op #	Descr	Type	Resource/Backshop data:	OF	ROC
0000	IN	P		1.00	MATRGB

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
32	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	2	Comments

THIS IS THE OPERATION WHERE RECEIVING AND UNCRATING OF THE GTE IS PERFORMED. THE GTE IS THEN SENT TO TEAR DOWN.

Wcd	Item Name	
13094A	GTE -397	ODCode CD

Op #	Descr	Type		OF	RCC
0010	DIS	P	Resource/Backshop data:	1.00	MATPGB

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
33	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?
1002	DS	MATPSI 397 ONLY	N
1003	DS	BACKSHOP 397	N
1006	DS	2NDSTG.DIFF.ASSY	N
1007	DS	ACCESSORY CASE	N
1008	DS	COMPRESSOR INLET	N
1009	DS	TURBINE NOZZLE 397	N
1010	DS	TURBINE BRG. HSG.	N

Ind	Seq#	
COM	3	Comments

THIS IS THE DISASSEMBLY OF THE GTE INTO ITS COMPONENT PARTS. MOST PARTS ARE THEN ROUTED TO THE MATPSI CLEANING AREA.

Wcd	Item Name	
13094A	GTE -397	OCCode CD

Op #	Descr	Type		OF	RCC
0020	KIT	P	Resource/Backshop data:	1.00	MATPGB

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
34	MF		1	C	0.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	4	Comments

THIS OPN. IS PRESENTLY HERE AS A PLACE HOLDER IN CASE WE WISH TO INCLUDE KITTING OPERATIONS IN THIS MODEL.

449

Wcd	Item Name	
13094A	GTE -397	CDCode CD

Op #	Descr	Type		OF	ROC
0040	TEST	P	Resource/Backshop data:	1.00	MATPGB

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
36	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	6	Comments

THIS RECORD IS MEANT TO REPRESENT THE FINAL TEST OPERATIONS. THIS WILL REQUIRE MORE DETAIL IN THE FINAL RUN TO SHOW NOT ONLY MANPOWER AND EQUIPMENT UTILIZATION, BUT ALSO THE AFFECTS OF REJECTS.

450

Wcd	Item Name	
13094A	GTE -397	ODCode CD

Op #	Descr	Type		OF	RCC
9999	OUT	P	Resource/Backshop data:	1.00	MATPGB

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
37	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	7	Comments

THIS IS THE OUTGOING OPERATION.

Wcd	Item Name	
13094A	GTE -397	ODCode CD

Op #	Descr	Type
0010	DIS	P

Resource/Backshop data:

OF	RCC
1.00	MATPGB

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
33	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?
1002	DS	MATPSI 397 ONLY	N
1003	DS	BACKSHOP 397	N
1006	DS	2NDSTG.DIFF.ASSY	N
1007	DS	ACCESSORY CASE	N
1008	DS	COMPRESSOR INLET	N
1009	DS	TURBINE NOZZLE 397	N
1010	DS	TURBINE BRG. HSG.	N

Ind	Seq#	
COM	3	Comments

THIS IS THE DISASSEMBLY OF THE GTE INTO ITS COMPONENT PARTS. MOST PARTS ARE THEN ROUTED TO THE MATPSI CLEANING AREA.

Wcd	Item Name	
13095A	GTE -180	ODCode CD

Op #	Descr	Type
0000	IN	P

Resource/Backshop data:

OF	ROC
1.00	MATPGB

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
38	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	8	Comments

THIS IS THE OPERATION WHERE RECEIVING AND UNCRATING OF THE GTES IS PERFORMED. THE GTE IS THEN SENT TO TEAR DOWN.

Wcd.	Item Name	
13095A	GTE -180	ODCode CD

Op #	Descr	Type	Resource/Backshop data:	OF	RCC
001	DIS	P		1.00	MATPGB

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
39	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?
1011	DS	MATPSI 180 ONLY	N
1012	DS	BACKSHOP 180	N
1013	DS	COMB. CHAMBER LNG.	N
1014	DS	TORUS TURBINE	N
1015	DS	1ST.STG.INLETASSY.	N
1016	DS	2NDSTG.COMPR.HSG.	N
1017	DS	WHEEL&SHAFTASSY.	N
1018	DS	2ND.STG.DIFF.HSG.	N
1019	DS	TURBINE NOZZLE 180	N
1020	DS	1ST.STG.COMPR.DIFF	N
1021	DS	2ND.STG.COMPR.DIFF	N
1022	DS	BEARING HSG.	N

Ind	Seq#	
COM	9	Comments

THIS IS THE DISASSEMBLY OF THE GTE INTO ITS COMPONENT PARTS. ALL PARTS ARE THEN ROUTED TO THE MATPSI CLEANING AREA.

Wcd	Item Name	ODCode CD
13095A	GTE -180	

Op #	Descr	Type		OF	RCC.
0020	KIT	P	Resource/Backshop data:	1.00	MATPGB

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
40	MF		1	C	0.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	10	Comments

THIS OPN. IS PRESENTLY HERE AS A PLACE HOLDER IN CASE WE WISH TO INCLUDE KITTING OPERATIONS IN THIS MODEL.

455

Wcd	Item Name	
13095A	GTE -180	ODCode OD

Op #	Descr	Type	Resource/Backshop data:	OF	ROC
0030	ASSY	P		1.00	MATPGB

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
42	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?
1032	AS	MATPSI 180 ONLY	N
1033	AS	BACKSHOP 180	N
1034	AS	COMB. CHAMBER LNG.	N
1035	AS	TORUS TURBINE	N
1036	AS	1ST.STG.INLETASSY.	N
1037	AS	2NDSTG.COMPR.HSG.	N
1038	DS	WHEEL&SHAFTASSY.	N
1039	AS	2ND.STG.DIFF.HSG.	N
1040	AS	TURBINE NOZZLE 180	N
1041	AS	1ST.STG.COMPR.DIFF	N
1042	AS	2ND.STG.COMPR.DIFF	N
1043	AS	BEARING HSG.	N

Ind	Seq#	
COM	11	Comments

THIS OPEATION IS MEANT TO REPRESENT THE FINAL ASSEMBLY OPERATIONS. IT IS ASSUMED HERE THAT ALL ITEMS HAVE BEEN OBTAINED FROM SUPPLY AND/OR KITTING.

Wcd	Item Name	
13095A	GTE -180	ODCode OD

Op #	Descr	Type		OF	ROC
0040	TEST	P	Resource/Backshop data:	1.00	MATPGB

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
4	3 MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	1 2	Comments

THIS RECORD IS MEANT TO REPRESENT THE FINAL TEST OPERATIONS. THIS WILL REQUIRE MORE DETAIL IN THE FINAL RUN TO SHOW NOT ONLY MANPOWER AND EQUIPMENT UTILIZATION, BUT ALSO THE AFFECTS OF REJECTS.

Wcd	Item Name
13095A	GTE -397

ODCode CD

Op #	Descr	Type
9999	OUT	P

Resource/Backshop data:

OF	FCC
1.00	MATPGB

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
44	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	13	Comments

THIS IS THE OUTGOING OPERATION.

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
GTE -180		Mistr	18	30	21	4

Standard Hours	Expected Hours	Envelope units
936		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP

Ind	Seq#	Comments
CCM	8	THIS IS FOR THE FIRST MODEL RUN ONLY.

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	9	13095A	1.000

ALC SA RCC MATPGB

			Quarterly Inductions			
PartName	Inv	Part type	1	2	3	4
MATPSI 180 ONLY		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	20	CLEAN	1.000
	WCD	32	INSPECT	1.000

Ind	Seq#	Comments
COM	18	-180 PARTS FOR MATPSI ONLY, FIRST RUN ONLY.

A/C SA RCC MATPGB

Part Name	Inv	Part type	Quarterly Inductions 1	2	3	4
BACKSHOP 180		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP	Ind	Seq#	Comments
S			COM	1 9	-180 NON-CRITICAL BACKSHOP PARTS, 1ST RUN ONLY

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	2 1	BBBBBB	1.000

461

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
COMB. CHAMBER LNG.		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP	Ind	Seq#	Comments
S			COM	20	-180 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	22	BBBBBC	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
TORUS TURBINE		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
COM	21	
-180 CRITICAL PART		

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	23	BBBBBD-	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
1ST.STG.INLETASSY.		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
CCM	22	-180 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	24	BBBBBE	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
2NDSTG.COMPR.HSG.		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
COM	23	-180 CRITICAL PART ONLY

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	25	BBBBBF	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
WHEEL&SHAFTASSY.		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP	Ind	Seq#	Comments
S			COM	24	-180 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	26	BBBBBH ------	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
2ND.STG.DIFF.HSG.		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
COM	25	-180 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	27	BBBBBI	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
TURBINE NOZZLE 180		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs.	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP	Ind	Seq#	Comments
S			COM	26	
			-180 CRITICAL PART		

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	28	BBBBBJ	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
1ST.STG.COMPR.DIFF		Mistr				

Standard Hcurs	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20	Weight	Max WIP	Ind	Seq#	Comments
S				COM	27	-180 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	29	BBBBBK	1.000

ALC SA RCC MATPGB

			Quarterly Inductions			
PartName	Inv	Part type	1	2	3	4
2ND.STG.COMPR.DIFF		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP	Ind	Seq#	Comments
S			COM	28	-180 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	30	BBBBBL	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
BEARING HSG.		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
COM	29	-180 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	31	BBBBBL	1.000

Wcd	Item Name	ODCode CD
CLEAN	MATPSI 180 ONLY	

Op #	Descr	Type	OF	RCC
0000	IN	P	1.00	MATPSI

Resource/Backshop data:

Seq #	Code	Resource	Amount	Distr	Parameters First	Second	Third
47	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	16	Comments

THIS IS FOR TIME IN TO AREA ONLY.

Wcd	Item Name	
CLEAN	MATPSI 180 ONLY	ODCode. OD

Op #	Descr	Type		OF	RCC
0010	BS	P	Resource/Backshop data:	1.00	MAEPNC

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
48	MF		1	N	96.00	72	

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	17	Comments

THIS REPRESENTS THE TIME THE PARTS DWELL IN MAEPNC CLEANING. THIS DATA IS TAKEN FROM WORK SAMPLING DATA.

Wcd	Item Name	
CLEAN	MATPSI 180 ONLY	ODCode CD

Op #	Descr	Type		OF	RCC
0020	CLN	P	Resource/Backshop data:	1.00	MATPSI

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
49	MF		1	C	0.50		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
CCM	18	Comments

THIS COVERS HAND CLEANING AND BLASTING OF PARTS. THIS OPN SHOULD BE DETAILED MORE FULLY IN SUBSEQUENT RUNS.

ALC SA RCC MATPGB

			Quarterly Inductions			
PartName	Inv	Part type	1	2	3	4
GTE -397		Mistr	46	46	42	0

Standard Hours	Expected Hours	Envelope units
960		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP

Ind	Seq#	Comments
COM	7	FOR FIRST MODEL RUN ONLY

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	8	13094A	1.000

ALC SA RCC MATPGB

			Quarterly Inductions			
PartName	Inv.	Part type	1	2	3	4
MATPSI 397 ONLY		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20	Weight	Max WIP
S			

Ind	Seq#	Comments
CCM	9	-397 PARTS WORKED IN MATPSI ONLY, FOR 1ST MODEL RUN.

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	10	CLEAN	1.000
	WCD	11	INSPECT	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
BACKSHOP 397		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help* ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
CCM	10	NON-CRITICAL BACKSHOP PARTS FOR IST RUN ONLY.

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	12	BS397	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions			
			1	2	3	4
2ND.STG.DIFF.ASSY		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
CCM	31	-397 CRITICAL PART (SHORT STACK)

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	34	DDDDDD	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
ACCESSORYCASE		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP	Ind	Seq#	Comments
S			COM	14	

-397 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	16	AAAAAD	1.000

ALC SA RCC MATPGB

			Quarterly Inductions			
PartName	Inv	Part type	1	2	3	4
COMPRESSOR INLET		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev.

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
COM	15	-397 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	17	AAAAAE	1.000

ALC SA RCC MATPGB

			Quarterly Inductions			
PartName	Inv	Part type	1	2	3	4
TURBINE NOZZLE 397		Mistr				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data help ->

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP
S		

Ind	Seq#	Comments
CCM	1 6	

-397 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	1-8	AAAAAG	1.000

ALC SA RCC MATPGB

PartName	Inv	Part type	Quarterly Inductions 1	2	3	4
TURBINE BRG. HSG.		Misir				

Standard Hours	Expected Hours	Envelope units
		1

Historical Data *help ->*

Aircraft	Mean	Std Dev	# of Obs	Log Mean	Log St Dev

Part Flag	80/20 Weight	Max WIP	Ind	Seq#	Comments
S			COM	30	-397 CRITICAL PART

	Ind	Seq#	WCD Name	Occurrence Factor
WCD[s]	WCD	33	XXXXXX	1.000

Wcd	Item Name	
INSPECT	MATPSI ONLY	ODCode OD

Op #	Descr	Type	Resource/Backshop data:	OF	ROC
0000	IN	P		1.00	MATPSI

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
61	MF		1	C	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

484

Wcd	Item Name	
INSPECT	MATPSI ONLY	ODCode CD

Op #	Descr	Type	OF	RCC
0001	INSP	P	1.00	MATPSI

Resource/Backshop data:

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
6	2 MF		1	N	0.50	0.25	

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

Wcd	Item Name	
INSPECT	MATPSI ONLY	ODCode OD

Op #	Descr	Type		OF	RCC
9999	OUT	P	Resource/Backshop data:	1.00	MATPSI

Seq #	Code	Resource	Amount	Distr	Parameters First	Second	Third
63	MF		1	N	2.00	1	

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

4 86

Wcd	Item Name	
BS397	BACKSHOP 397	ODCode OD

Op #	Descr	Type
0001	PROC	P

Resource/Backshop data:

OF	ROC
1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
4	6 MF		1	E	30.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	1 5	Comments

THIS OPS FILE REPRESENTS ALL NON-CRITICAL -397 PARTS WHICH TRAVEL TO A BACKSHOP. REFER TO THE -397 HISTOGRAM FOR THE DISTRIBUTION, AND THE AVERAGE (WHICH WAS TAKEN FROM THE FREQUENCY OF OCCURRENCE).

Wcd	Item Name	ODCode CD
TA813F	2ND.STG.DIFF.ASSY	

Op #	Descr	Type
0001	PROC	P

Resource/Backshop data:

OF	ROC
1.00	MATALL

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
64	MF		1	E	3792.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

Wcd	Item Name	
TA537F	ACCESSORYCASE	ODCode: CD

Op #	Descr	Type
0001	PROC	P

Resource/Backshop data:

OF	RCC
1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
65	MF		1	E	25.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

Wcd	Item Name	
TG816F	COMPRESSOR INLET	ODCode CD

Op #	Descr	Type
0001	PROC	P

Resource/Backshop data:

OF	RCC
1.00	MATALL

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
66	MF		1	E	2088.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

Wcd	Item Name	
TA841F	TURBINE NOZZLE 397	ODCode CD

Op #	Descr	Type
0001	PROC	P

Resource/Backshop data:

OF	RCC
1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
67	MF		1	E	1008.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

#91

Wcd	Item Name	
TG847F	TURBINE BRG. HSG.	ODCode CD

Op #	Descr	Type		OF	RCC
0001	PROC	P	Resource/Backshop data:	1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
68	MF		1	E	2376.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind Seq#

Comments

492

Wcd	Item Name	
BS180	BACKSHOP 180	ODCode CD

Op #	Descr	Type		OF	RCC
0001	PROC	P	Resource/Backshop data:	1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
45	MF		1	T	10.00	50	1.00

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#	
COM	14	Comments

THIS REFERS TO ALL -180 PARTS WHICH TRAVEL TO BACKSHOPS. SEE THE -180 FLOWDAY HISTOGRAM TO GET AN IDEA OF THE DISTRIBUTION, AND THE MIN,MODE,MAX VALUES.

493

Wcd	Item Name	
TG624D	1ST.STG.COMPR.DIFF	ODCode CD

Op #	Descr	Type		OF	RCC
0.001	PROC	P	Resource/Backshop data:	1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
58	MF		1	E	40.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind Seq#

Comments

Wcd	Item Name	
TG623D	1ST.STG.INLETASSY.	ODCode CD

Op #	Descr	Type
0001	PROC	P

Resource/Backshop data:

OF	RCC
1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
53	MF		1	E	46.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

495

Wcd	Item Name	
TG629D	2ND.STG.COMPR.DIFF	ODCode CD

Op #	Descr	Type		OF	RCC
0001	PROC	P	Resource/Backshop data:	1.00	MATALL

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
59	EQ		1	E	2328.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

Wcd	Item Name	
TG628D	2ND.STG.DIFF.HSG.	ODCode CD

Op #	Descr	Type		OF	RCC
0001	PROC	P	Resource/Backshop data:	1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
56	MF		1	E	1584.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind Seq#

Comments

477

Wcd	Item Name	
TG622D	2NDSTG.COMPR.HSG.	ODCode OD

Op #	Descr	Type		OF	RCC
0001	PROC	P	Resource/Backshop data:	1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
54	MF		1	E	87.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind Seq#

Comments

Wcd	Item Name	
TG631D	BEARING HSG.	ODCode CD

Op #	Descr	Type
0001	PROC	P

Resource/Backshop data:

OF	RCC
1.00	MATALL

Parameters

Seq #	Code	Resource	Amount	Distr	First	Second	Third
60	MF		1	T	744.00	6000	15816

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind	Seq#

Comments

477

Wcd	Item Name	
TG611D	COMB. CHAMBER LNG.	ODCode OD

Op #	Descr	Type
0001	PROC	P

Resource/Backshop data:

OF	ROC
1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
51	MF		1	E	24.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind Seq#

Comments

Wcd	Item Name	
TG615D	TORUS TURBINE	ODCode OD

Op #	Descr	Type		OF	RCC
0001	PROC	P	Resource/Backshop data:	1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
52	MF		1	E	36.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind Seq#

Comments

561

Wcd	Item Name	
TG618D	TURBINE NOZZLE 180	ODCode CD

Op #	Descr	Type		OF	RCC
0001	PROC	P	Resource/Backshop data:	1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
57	MF		1	E	2112.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind Seq#

Comments

Wcd	Item Name	
TG645D	WHEEL&SHAFTASSY.	ODCode CD

Op #	Descr	Type		OF	RCC
0001	PROC	P	Resource/Backshop data:	1.00	MATALL

					Parameters		
Seq #	Code	Resource	Amount	Distr	First	Second	Third
55	MF		1	E	2736.00		

Assembly/Disassembly data

Seq #	Code	Subcomponents Name	Same ?

Ind Seq#

Comments

503

PART DATABASE ERROR AND STATISTIC REPORT

Tuesday, September 25, 1990 7:32:24 PM

PART by WCD Total # of Parts 21

PART	WCD	#of ops/wcd	# of WCDs or Error msg
1ST.STG.COMPR.DIFF	TG624D	1	1
1ST.STG.INLETASSY.	TG623D	1	1
2ND.STG.COMPR.DIFF	TG629D	1	1
2ND.STG.DIFF.ASSY	TA813F	1	1
2ND.STG.DIFF.HSG.	TG628D	1	1
2NDSTG.COMPR.HSG.	TG622D	1	1
ACCESSORY CASE	TA537F	1	1
BACKSHOP 180	BS180	1	1
BACKSHOP 397	BS397	1	1
BEARING HSG.	TG631D	1	1
COMB. CHAMBER LNG.	TG611D	1	1
COMPRESSOR INLET	TG816F	1	1
GTE -180	13095A	6	1
GTE -397	13094A	6	1
MATPSI 180 ONLY	CLEAN INSPECT	4 3	2
MATPSI 397 ONLY	CLEAN	4	2

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PART DATABASE ERROR AND STATISTIC REPORT

Tuesday, September 25, 1990

	INSPECT	3	
TORUS TURBINE	TG615D	1	1
TURBINE BRG. HSG.	TG847F	1	1
TURBINE NOZZLE 180	TG618D	1	1
TURBINE NOZZLE 397	TA841F	1	1
WHEEL&SHAFTASSY.	TG645D	1	1

WCD by PART

WCD	Occurrence Factor	PART
13094A	1.000	GTE -397
13095A	1.000	GTE -180
AAAAAA	1.000	
AAAAAB	1.000	
AAAAAC	1.000	
AAAAAH	1.000	
BS180	1.000	BACKSHOP 180
BS397	1.000	BACKSHOP 397
CLEAN	1.000 1.000	MATPSI 180 ONLY MATPSI 397 ONLY
INSPECT	1.000 1.000	MATPSI 180 ONLY MATPSI 397 ONLY
TA537F	1.000	ACCESSORY CASE
TA813F	1.000	2ND.STG.DIFF.ASSY
TA841F	1.000	TURBINE NOZZLE 397
TG611D	1.000	COMB. CHAMBER LNG.
TG615D	1.000	TORUS TURBINE
TG618D	1.000	TURBINE NOZZLE 180

TG622D	1.000	2NDSTG.COMPR.HSG.
TG623D	1.000	1ST.STG.INLETASSY.
TG624D	1.000	1ST.STG.COMPR.DIFF
TG628D	1.000	2ND.STG.DIFF.HSG.
TG629D	1.000	2ND.STG.COMPR.DIFF
TG631D	1.000	BEARING HSG.
TG645D	1.000	WHEEL&SHAFTASSY.
TG816F	1.000	COMPRESSOR INLET
TG847F	1.000	TURBINE BRG. HSG.
WCD004	1.000	
wcdsae	1.000	

ERRORS and WARNINGS

	PART	Q1	Q2	Q3	Q4	COUNT
Induction Warning (missing quarters)						all

OPERATION DATABASE ERROR REPORT

Tuesday, September 25 1990 7:47:10 PM

ERROR TYPE	WCD	Op #	Op Type	# OF ERRORS
No RCC Name				all correct
Bad or No Occ Fac				all correct
No OD code				all correct
No resource				all correct
No quantity				all correct
No distribution				all correct
No time in Param1				all correct
Bad Param2				all correct
Bad Param3				all correct
No DS/AS Name				all correct
No SameOne flag				all correct

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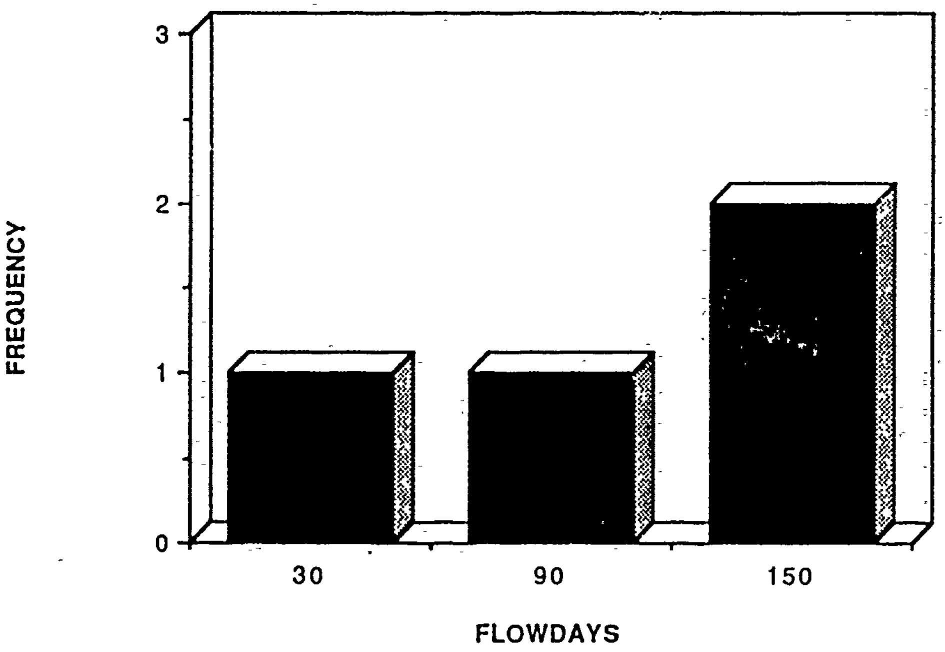
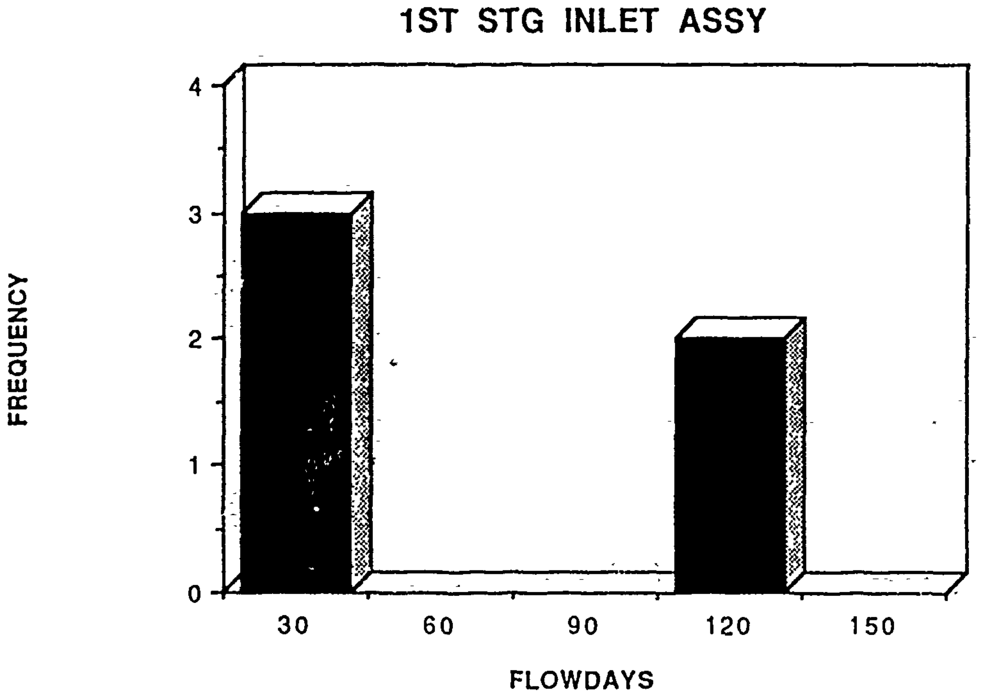
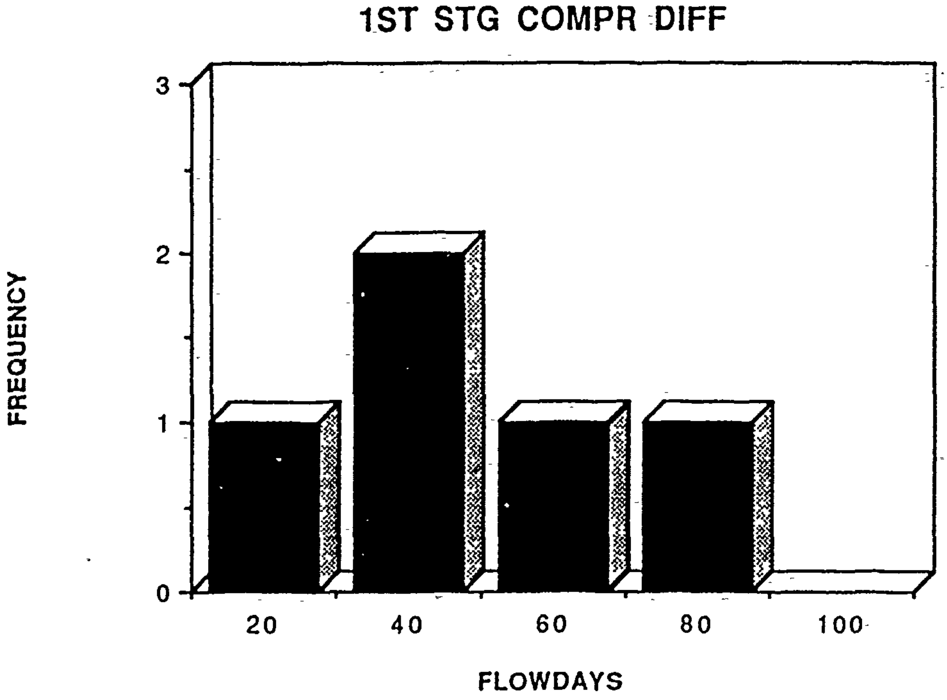
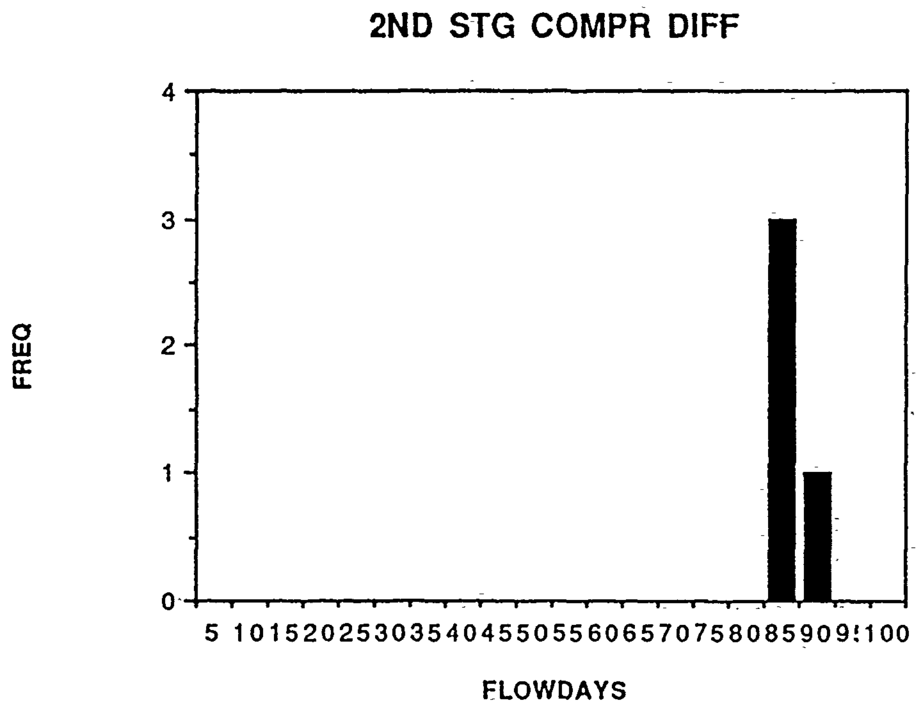
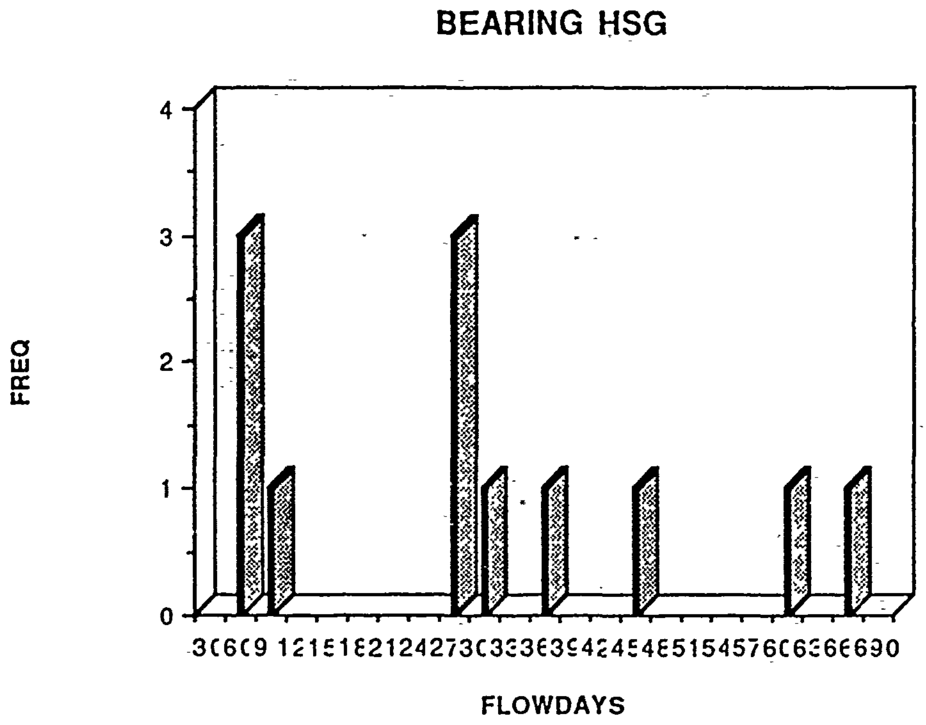
2ND STG COMPR HSG

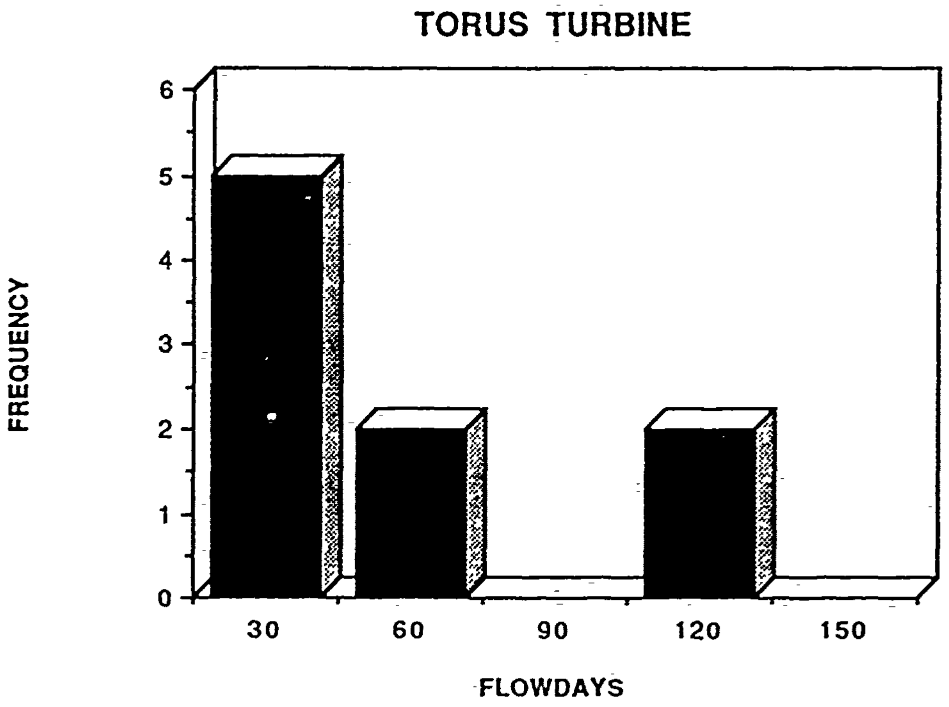


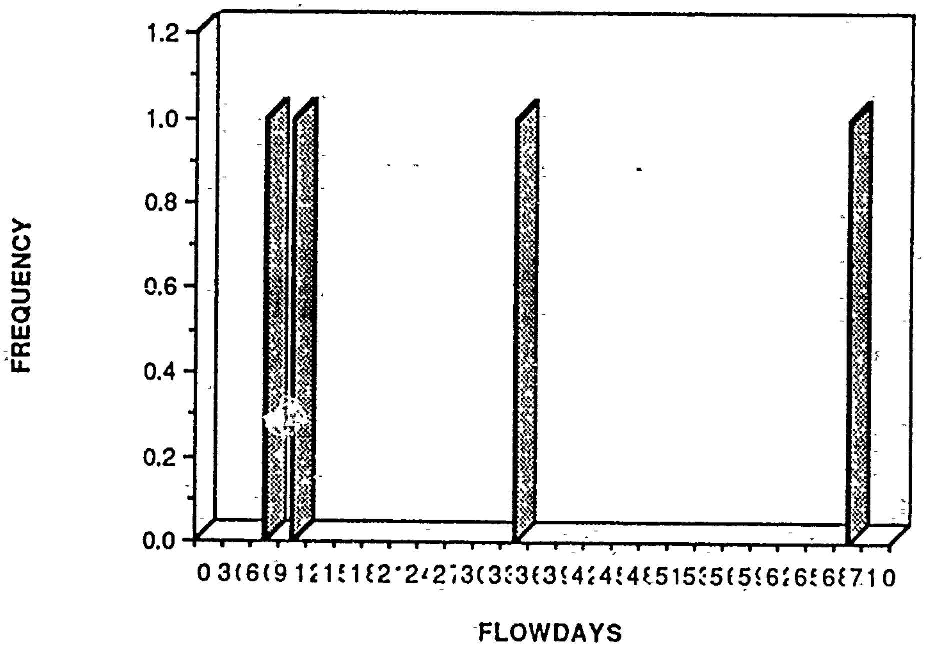

1ST STG INLET ASSY
FREQUENCY
0
1
2
3
4
30
60
90
120
150
FLOWDAYS


1ST STG COMPR DIFF
FREQUENCY
3
2
1
0
20
40
60
80
100
FLOWDAYS


2ND STG COMPR DIFF
FREQ
4
3
2
1
0
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
FLOWDAYS

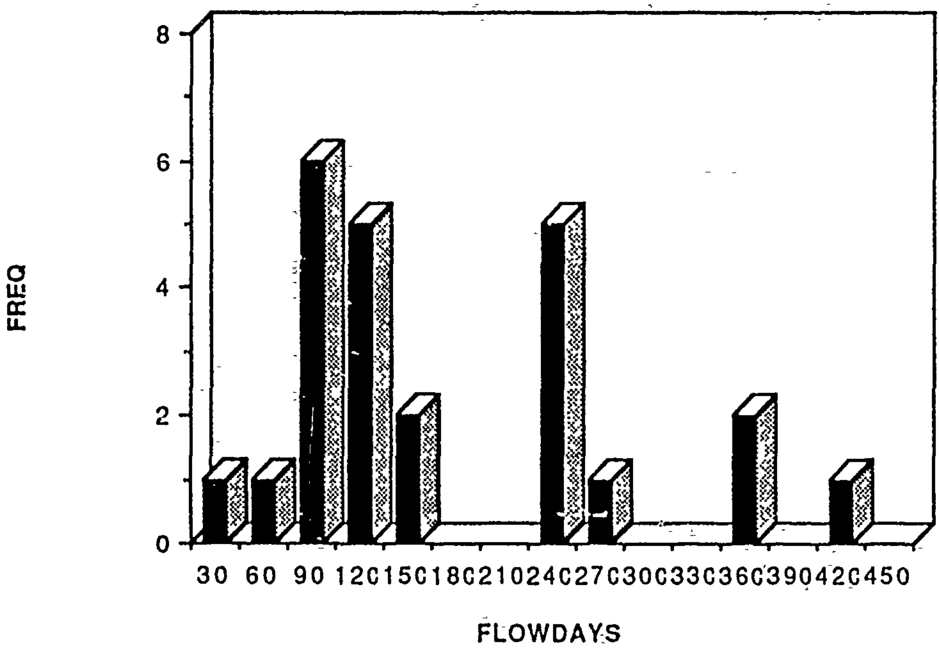
BEARING HSG
FREQ
4
3
2
1
0
30609 12151821242730333639424548515457606366690
FLOWDAYS


TORUS TURBINE
FREQUENCY
0
1
2
3
4
5
6
30
60
90
120
150
FLOWDAYS

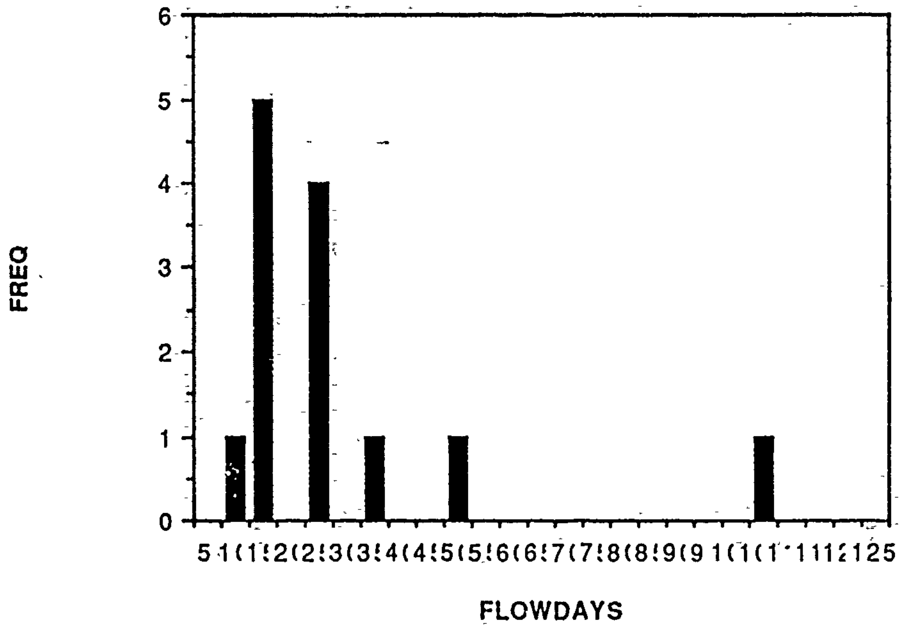

WHEEL & SHAFT

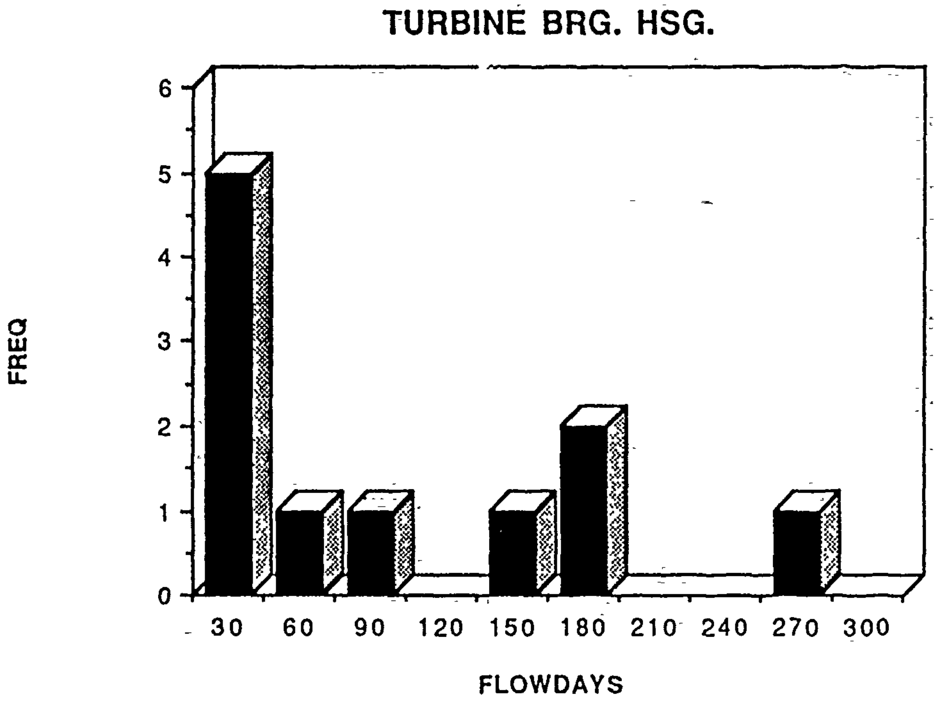
1.2
1.0
0.8
0.6
0.4
0.2
0.0
FREQUENCY
0 3(6(9 1:1:1:2'2'2;3(3:3(3:4:4:4:5 1 5:5(5:6:6:6:7 1 0
FLOWDAYS

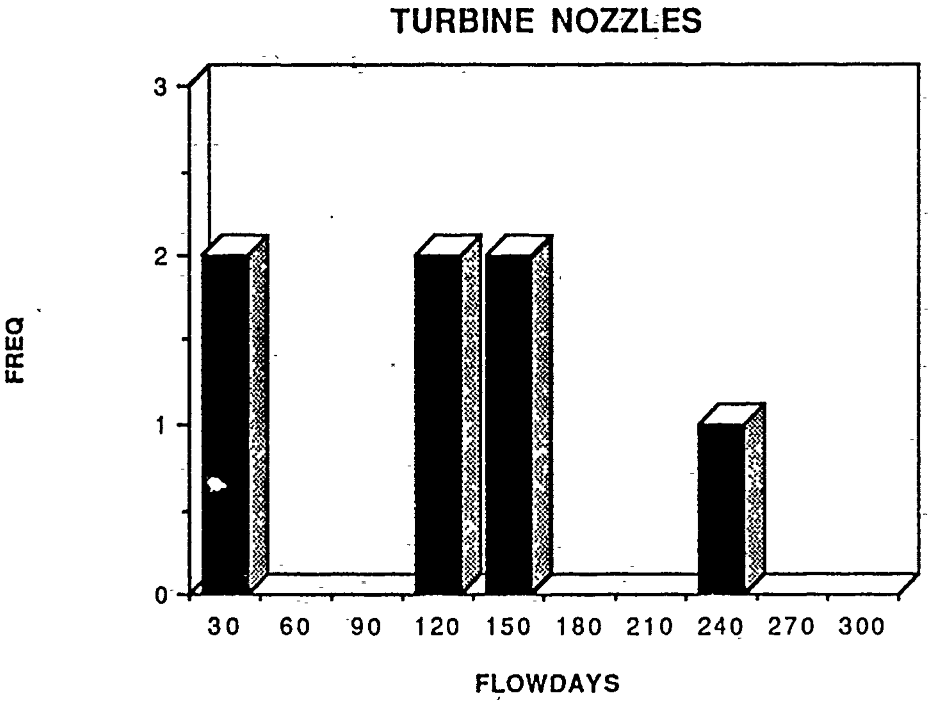
2ND STG DIFF ASSY. (SHORTSTACK)

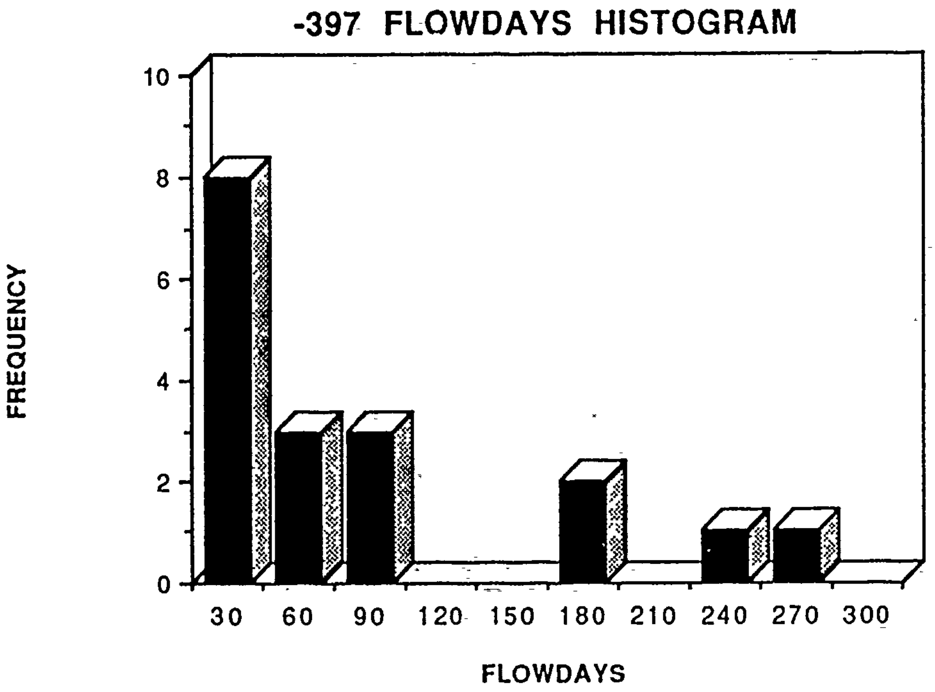


ACCESSORY CASE



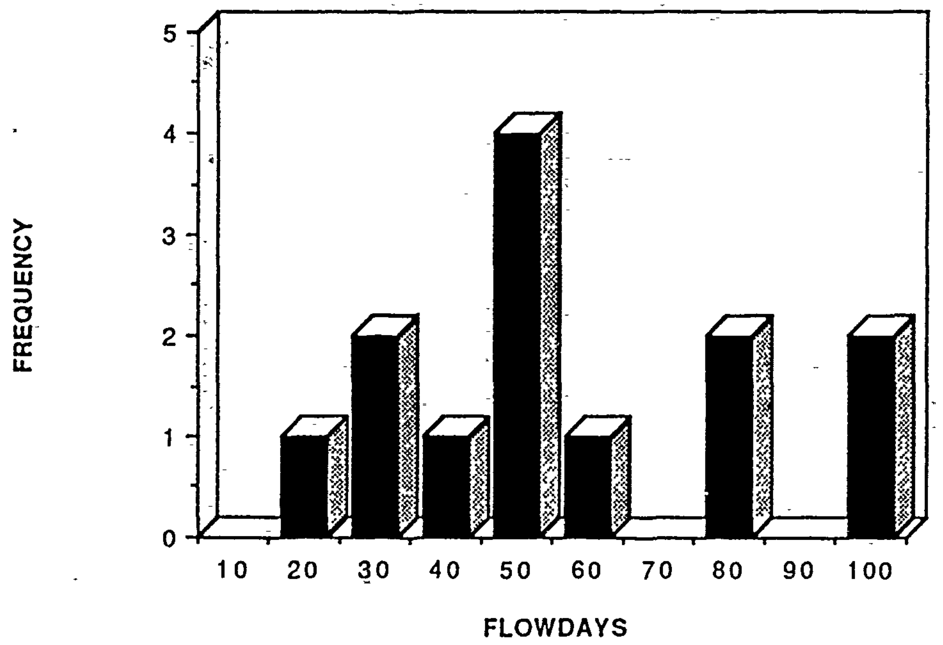

TURBINE BRG. HSG.
FREQ
0
1
2
3
4
5
6
30
60
90
120
150
180
210
240
270
300
FLOWDAYS


TURBINE NOZZLES
FREQ
3
2
1
0
30
60
90
120
150
180
210
240
270
300
FLOWDAYS



-397 FLOWDAYS HISTOGRAM

-180 FLOWDAYS HISTOGRAM



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ENGINEERING NOTES

EMPLOYEE P Clarker DATE 8/27/90 PAGE NO. 68

RCC MATPSI SUBJECT work sampling

8/27/90 -

The following are my initial thoughts on where the work sampling collection nodes should be, as well as some ideas on how we should approach the sampling itself.

NODE ONE

I feel that we should initially tag the end items as they are uncrated, and track them to the disassembly area. Component parts that are <u>not</u> sent to MATPSI cleaning or inspection should be identified, tagged, and tracked to the appropriate backshop*. This includes those items that are sent to the bld. 360 cleaning area. This raises an important point. We must count the number of items in a basket, as we will likely have to tag the basket itself in many cases, rather than the components. This is especially true in these basket cleaning operations, although the same concept may apply to various batch operations in other RCCs.

NODE TWO

Those parts entering the MATPSI cleaning area are going to be very hard to tag. I think that the baskets should be tagged at the time they enter the area, and the parts timed as they go through the system, either by myself or, preferably, the supervisor by logging them in at the start and stop of specific operations. I think this area will be tough as the processes appear to be relatively short for individual item cleaning, the volume is high, and the area is rather cramped, making visual parts tracking difficult to perform.

NODE THREE

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ENGINEERING NOTES

EMPLOYEE [illegible]
DATE 8/22
PAGE NO. 69
RCC [illegible]
SUBJECT Work Sampling

Those items routed to the MATPSI inspection area should be tagged as they enter their 24 hr. acclimation period. I think it is important to tag them as they enter the area, since they may stay here longer than the required 24 hours.

NODE FOUR

The parts that are routed from MATPSI should be tagged upon completion of the last operation. Those items traveling directly to parts pool should be handled differently than those going to backshops. When the item reaches the parts pool it should be logged in. Parts that are kitted should be tagged and tracked during the kitting process. Both those items sent individually and in kits to final assembly should be tracked as they leave parts pool on a daily basis during the period of our study. This is due to the fact that we also want to track the time required to kit and flow parts through the parts pool, although this will probably require a sustained efforts if it is to provide truly meaningful results. The important point is to try and get an idea of how well the parts pool supports production. This is going to be an intensive effort, and probably time consuming, definitely requiring daily monitoring. It may also present a good opportunity for identifying potential process improvements.

NODE FIVE

End items or major assemblies leaving final assembly should be tagged and tracked to final test area.

NODE SIX

Those items failing final test at any stage should be closely tracked. Dwell time and internal handling of items in this area should be analyzed with some care.

DDB SECTION CODE
DDB PAGE NO.

ENGINEERING NOTES

EMPLOYEE Clacker DATE 8/22/[illegible] PAGE NO. 10

RCC [illegible] SUBJECT [illegible] Costing

NODE SEVEN thru whatever

All items travelling to a backshop should be tagged in some manner and tracked through the whole process until they (or a like part chosen for ease of accomplishing analysis) are made available to final assembly. See note on backshop internal tracking procedures.

IN GENERAL: The main point is to monitor this system daily. Since I believe that it offers a good opportunity for engr. assessment suggestions, the time invested should pay off. We can expect some attrition in lost items and components, as well as a certain amount of corruption in the data being collected through human error. Again the main thing is to be careful to stay on top of the activity. It will probably be necessary to tag more items to make up for those lost for one reason or another, so monitoring is very necessary. The procedures to use for tracking actual hands on labor time is still not clear, but log book sign in by the supervisor is probably the best way to proceed.

*NOTE: The receiving area in each backshop, and the manner in which the part is routed to the appropriate technician should be documented in detail. How the part is routed to its staging area after the last operation is completed should also be documented. How material handlers notify production of incoming work, and how they know when to pick items up for routing are all important questions. These considerations will be necessary for <u>each</u> backshop we encounter.

<u>BACKSHOP CONSIDERATIONS</u> -

DDB SECTION CODE ____ DDB PAGE NO. ____

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE 5/22/90 PAGE NO. [illegible]

RCC [illegible] SUBJECT Work Sampling

(1) I am by no means a plating expert. However, I do have some knowledge gained both through direct observation, study, and discussions with our program's resident expert. With these limitations in mind, these are my recommendations and thoughts regarding work sampling in the plating shop:

Since plating is a batch process, and we can't have any tags on the part while it is being processed, we are back to tagging either the WCDs or the delivery baskets. I favour the basket approach, personally. The parts routed to the plating area can be counted and logged in when they arrive. The quantity of a specific part could be logged in at the beginning of the plating operation (probably at the masking operation) and logged out at the last operation. The parts would be logged out by the material handlers when they routed them to another RCC. Since the process times are pretty much set by the nature of the electro-chemical reactions themselves, we would expect the physical processing of these items to be fairly standardized.

[We really should try and get a rough idea how much WIP is in any particular area, as it appears that a great many parts are simply lying about the shop floors. If it proves impossible to do this in the GTE processing areas for this task order, it should still be done prior to the implementation of any automated scheduling or tracking systems. It would also allow us to get a better idea of why some parts set for long periods, while others process in a much shorter period.]

(2) The machine shop has similar batching considerations. Here, though, the parts have to be manipulated by hand for the most part. The main constraint for the batch sizes is probably the time required for machine tear down and set-up. In this area, we could probably tag the parts themselves (or the paperwork). Again, the

ENGINEERING NOTES

EMPLOYEE C Parker DATE 8/27/90 PAGE NO. 72

RCC MATLST SUBJECT Work Sampling

items can be logged as they are worked, and the time for material handling logged separately.

(3) Heat Treat is probably also a batch process also, although to a lesser extent. The basket tagging method will probably be the method of choice here, or at least a log of each part delivered.

Note: One thing we need to realize. If you overwhelm the shops with certain components, you are not going to get a "first in, first out" flow. This is why some parts flow through the system in 20 days, while like parts requiring exactly the same repairs may dwell in the backshops for incredibly long periods. It is simple human nature: If the last basket delivered is on top, that's the one you take from.

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE [illegible] PAGE NO. 2

RCC [illegible] SUBJECT [illegible]

8/28/90 -

We met with Mr. Cummings, the MAE scheduling branch chief, this morning. Also at the meeting were:

Roland Moore	Plating shop section chief
Jesse Ornelas	Bld. 360 cleaning section chief
Herb Rippa	Bld. 360 engineering support
Danny Gonzales	MATEA T.O. #15 contact
Susan Schattle	MATW ALC contact
Greg Gardner	MDMSC
Ken Premo	MDMSC
Phillip Parker	MDMSC

We discussed the subject of work sampling at this meeting. Some discussion occurred regarding past efforts at tracking actual flow times. Their was some skepticism as to how effective this approach will be, but everyone pledged their support for the effort. Mr. Moore made an interesting statement during this meeting. He mentioned that unrealistic scheduling (not based on actual production needs) influenced the backshop production of GTE parts in a negative manner. Apparently, components are often artificially prioritized by the requesting RCC, which would naturally erode trust in future requests for backshop support. The effect of this, according to Mr. Moore, is that GTE parts remain in backshop until they can be fit into the backshop's overall workload. If this is true, it points to the need for realistic scheduling based strictly on production needs.

This question of realistic scheduling is one of increasing importance in my mind. In my <u>opinion</u>, and based on my observations to date, it appears that the most significant problems in the GTE

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE [illegible] PAGE NO. 24

RCC [illegible] SUBJECT Scheduling considerations

production process are:

(1) Lack of component parts accountability.
(2) Lack of process control (inadequate quality control, unstructured material flow and handling practices, inadequate scheduling of component processing, etc.).

I really feel that the implementation of a structured scheduling system would solve many of these problems, and help to define the actions required to solve others (i.e., quality and reject problems). I have already mentioned that Mr. Gonzales is trying to implement a part's accountability/scheduling system in the GTE production facility itself, but I am afraid that the scheduling of items through the backshops will require other efforts if true improvements are to be made. Basically, it is going to take a change in the way the GTE overhaul and repair process is monitored and administrated. It will also require, in my opinion, a complete inventory of all WIP, and well defined material handling and processing guidelines. I realize that while changing the way people perform their jobs can be the most difficult tasks of all, the fact is that no matter how many state-of-the-art parts tracking systems are installed, they will not be effective without a disciplined work force willing to follow established directives. If disciplined and structured work habits can be implemented, these may reduce the need for capital intensive automation systems. I would also maintain that a disciplined work force is more capable of achieving high quality craftsmanship, and are more content in their individual jobs.

With these thoughts in mind, and given the high exposure that the work sampling will give us to floor operations, we will attempt to identify those areas where administrative controls can be applied to the present system in both the scheduling of items and the actual

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ENGINEERING NOTES

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EMPLOYEE

DATE 8/28/80

PAGE NO. 25

RCC 11ATPSE

SUBJECT work sampling

hands-on processing of items. Where applicable, we will suggest structured approaches to solving specific process problems.

DDB SECTION CODE

DDB PAGE NO.

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ENGINEERING NOTES 1/2

EMPLOYEE [illegible] DATE 8/29/90 PAGE NO. 26

RCC 1118 TPSI SUBJECT Tasks

To do list
8/29/90

Note: Many of these items are already in progress, and some are nearing completion. I will update the status of these items as they are completed.

- Set up an appointment to talk to Mr. Moore in the plating shop. Discuss the work sampling effort, identify who to interview on batching considerations and process questions, and discuss questions of how component handling and scheduling is done.

- Set up appointments with material handlers in all areas which need to be studied. Have these people take us around and show us where items are placed, how they are transported, how production is notified of their presence, etc.

- Check with Mr. Garcia in Machine shop. See if he can set up a meeting with the Machine shop personnel as we discussed earlier. The work sampling could also be discussed at that time.

- Check on the status of the historical WCDs and report *preliminary* results (see below).

- Complete the presentation sheets and *documen* [illegible] for the high rollers in flow time. Note: *Are* [illegible] for "high dollar" items?

- Construct the ops files directly from the WCDs at this point (Danny doesn't want to influence the work sampling negatively. He has repeatedly requested that we do not perform interviews at this time).

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ENGINEERING NOTES

EMPLOYEE P Parker

DATE [illegible]

PAGE NO. [illegible]

RCC M10TPSI

SUBJECT [illegible]

- Construct the item profiles with both the end item and the subassembly considerations. Discuss with Scott the implications of ASSY/DISASSY, no return to same parent item, high WIP levels, INV(ENTORY) considerations, etc.

- Construct Resource Profiles (MP only at this time) ASAP for each RCC. Need to obtain the number of WGs assigned and a shredout of those who are on disabled and training for the FY90 period. Make sure that the Suzie Guzeman stuff is sufficient for our needs.

- Need to obtain floor layouts , organization charts, and 80/20 listings for all RCCs.

- Review Ken's notes and determine course of action on vibe problem. Research cold jet issues. Get list of contacts and identify components which are candidates for this technology. Notify Greg by 9/4/90. Order software.

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ENGINEERING NOTES

EMPLOYEE P Parker
DATE 8/29/90
PAGE NO. 78
RCC MATPS.I
SUBJECT work sampling

The following is a listing of data relative to the work sampling effort. A memo which was compiled from requests for assistance and coordination by our ALC team mates (found within the body of this discussion) follows.

Subject: Work sampling and associated Engineering Assessment: Plan of action.

Reported Condition: While inductions of certain GTE end items have increased, relative output has decreased. Demand from the field has increased due to lower field inventories and recent surge conditions.

Observation: Historical WCDs show extremely ~~low~~ Long flow times for many items. Physical observation of both in-house and backshop areas reveals a great deal of WIP inventory at various locations. Interviews with area' supervisors indicates dissatisfaction with unrealistic scheduling and lax and disorganized material handling. ← opinion; [illegible]

Opinion: It appears that a relatively severe management and accountability problem exists. Individual workers and supervisors are not taking adequate responsibility for parts accountability, existing material handling is not properly structured or regulated, and established scheduling procedures are not being followed. (Supporting documentation follows).

Suggested Action: In order to quantify the actual degree to which the supposed problems exists, as well as to obtain accurate input and validation data for simulation model, work sampling is required.

Objectives: Support in-house efforts to solve these problems, as well as improve quality of process characterization data.

Discussion:

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE 8/29/90 PAGE NO. ______

RCC MATPSI SUBJECT work sampling

Permission has been received to perform work sampling study on selected parts (to be specified ASAP) by both MAT and MAE branch supervision. Formal written notification of this permission will follow. Please refer to appropriate sections of MDMSC engineering notes for details of approval process. Tags have been printed at MDMSC expense to support this effort.

In order to perform the required work sampling tasks, it will be necessary to gain a detailed knowledge of the routing and material handling techniques presently used. For this reason, MDMSC will contact appropriate scheduling and material handling personnel with the objective of accomplishing actual observation of these activities in the daily processing of GTE components (coordination by MATEA personnel required). All associated activities will be documented (engr. notes, floor layouts, flow charts, etc.) and presented in CSR findings. All findings will be presented to MATEA contact for review before incorporation into CSR or other formal presentation. Errors in these findings will be corrected as necessary at time of review. Other individuals will be shown the preliminary findings at MATEA contact's discretion. MATEA contact will be provided weekly updates of all activities associated with this task.

Collection nodes previously identified will be confirmed or modified as the material handling system is analyzed. Given the relatively short amount of time remaining available to performance of this effort, tagging shall begin as soon as possible. If selected collection nodes prove inadequate, tagging will be performed at new locations determined to be more suitable for the task. While this may appear to be sub-optimal, it represents the most effective use of available time in my opinion.

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ENGINEERING NOTES

EMPLOYEE C Parker DATE 8/29/90 PAGE NO. 807
RCC [illegible] SUBJECT work sampling

In order to determine where established scheduling and material handling procedures are inadequate or not being properly followed, MDMSC proposes to perform an analysis of relevant MAOI and related procedural instructions. MATEA and MAWF coordination is required for this effort. Existing procedural documentation must be provided as soon as possible. Assistance is also requested in obtaining floor layouts and organizational charts for areas to be studied, personnel staffing levels, and 80/20 lists of each area's total workload.

Start date for actual tagging of items is expected on or before 9/4/90. Initial length of study is expected to be one month from this date, although study may continue in a modified form for entire length of Task Order at MATEA contact's request (subject to MDMSC/ALC joint approval).

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ENGINEERING NOTES

EMPLOYEE Parker DATE 8/30/90 PAGE NO. 81

RCC [illegible] SUBJECT Vibration problems

8/30/90 -

Danny Gonzales is out of town until 9/5/90. I was tasked with contacting the scheduling personnel responsible for material handling in both the MAT and MAE divisions. Unfortunately, my contact in scheduling, Mr. Zurita, was not available. I was unable to contact his alternate. Mr. Cummings, who we talked to earlier regarding the MAE scheduling support, provided me with the names of the scheduling personnel in the cleaning, plating, and heat treat areas who will need to be contacted. I have attempted to call each of these gentlemen today, with no success.

I have spent some time with Ken Premo during the last several days in coordinating and assisting with his efforts in studying the reported vibration problem. I have reviewed his notes on the subject, and concur with his findings and observations. Please refer to Mr. Premo's notes for specifics. We have also collected information from several different log books relating to final test failures, retest data, and various other information. This data will be formatted, graphed, and presented at a later time. This data will most likely be presented in the CSR in some form. Discussions with our ALC contacts indicate that they were aware of many of our findings. We were somewhat distressed by the fact that there does not appear to be any actual ALC documentation of these problems, which we feel are relatively severe. In our opinion, there appears that there is a lack of quality control in many areas of the GTE process, as well as the need for more training and accountability in the various repair and inspection processes involved. These subjects will be discussed in more detail in a later section of these notes, and will be available for comment by our ALC contacts before the CSR is written in even draft form.

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ENGINEERING NOTES

EMPLOYEE Parker DATE 8/30/90 PAGE NO. 82

RCC MAT PSI SUBJECT Off-site

Tomorrow has been designated as an energy conservation day, which means the work areas will be closed to non-essential personnel. The IPI group will use this time for an off-site meeting to discuss several task order issues, as well as various program concerns, desired model enhancements, and other items of interest. One particular topic I plan to bring up is the need for a more structured approach to engineering assessments in the ALC environments for future task orders. I have felt for some time that this is an area requiring attention by all involved MDMSC team members.

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ENGINEERING NOTES

EMPLOYEE Parker DATE 9/4/90 PAGE NO. 83

RCC [illegible] SUBJECT Work sampling

9/4/90 -

We obtained our formal notification of permission to begin work sampling this morning (letter attached). This letter is being distributed to various personnel throughout the GTE RCCs. I was unable to find out whether the letter would be distributed across division lines and throughout the various backshops. If not, I envision a rather time consuming effort in disseminating information to the involved parties.

As the parts tracking tags we are having printed have not yet arrived, I asked Mr. Gardner to check on their status. It is essential that we obtain these as soon as possible.

I was still unable to contact Mr. Zurita to discuss the "work sampling" effort. I did speak to Deborah Hall, who is his alternate. Ms. Hall did not foresee any difficulties with the parts tracking effort, although she referred me to a Mr. Perez, who handles both the parts pool and the material handling personnel. Mr. Perez will therefor be one of the key personnel involved in this effort. I left messages with Mr. Perez's office several times this afternoon, but he never returned my calls. I will attempt to contact him tomorrow morning.

Mr. Premo and I spent the rest of the day familiarizing ourself with logical areas for tagging and collecting of the parts tracking data.

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04 SEP 1990

FROM: MATE

SUBJECT: Industrial Process Improvement Work Sampling

TO: MATP
MATS
IN TURN

1. The McDonnell Douglas Missile Systems Company (MDMSC) is in the process of building a computer simulation model of the GTE overhaul repair process. This model requires several types of data to be inputted before it can be used for process streamlining, experimentation, validation of equipment purchases in excess of two million dollars, and validation of all military construction projects. Data collected to date includes labor standards, repair operations, historical WCD data, induction schedules, and manpower/equipment availability/utilization.

2. The most critical data element in the simulation model is actual flow time. MDMSC proposes to collect this data using work sampling techniques requiring the "tagging" and tracking of these parts through the repair process. Although this method is labor intensive and time consuming, it remains the most accurate collection technique for current data. Fifteen (15) "critical" items, items which historically have long flow times, have been identified as parts to be tracked. These items are:

ENGINE	ITEM	P/N
GTCP85-180	Combustion Chamber Liner	899244-3 ✓
GTCP85-180	Torus Turbine	968959-2 ✓
GTCP85-180	1st Stage Inlet Assembly	698197-1 ✓
GTCP85-180	2nd Stage Compressor Housing	698198 ✓
GTCP85-180	Wheel and Shaft Assembly	3606982-1 ✓
GTCP85-180	2nd Stage Diffuser Housing	698195-1 ✓
GTCP85-180	Turbine Nozzle	968886-1 ✓
GTCP85-180	1st Stage Compressor Diffuser	698194-1 ✓
GTCP85-180	2nd Stage Compressor Diffuser	892290-1 ✓
GTCP85-180	Bearing Housing	696659-160 ✓
GTCP85-397	2nd Stage Housing	372647-100 ✓
GTCP85-397	Deswirl	76443 ✓
GTCP85-397	2nd Stage Diffuser	373823 ✓
GTCP85-397	Accessory Case	372896-16 ✓
GTCP85-397	Compressor Inlet APU (MC's)	376283-20 ?
-397	Turbine nozzle	378513-4
-397	Turbine bearing housing	373237-200, 250

3. Request MATP and MATS assistance in collecting this data. The schedulers and parts expediters are requested to mark the time, day, and RCC's from which the tagged items are moved to and from. The data can be collected on cards (see Atch 1) which will be attached to WCD package. This information will be collected by MDMSC personnel at several collection nodes across the repair process. Production Foreman are requested to mark the time and day work begins/ends on a tagged item. This data can be marked in a log book, also to be collected by MDMSC personnel. The period of work sampling will be one month, effective 04 Sep 90.

SEP 1981

4. The impact on Production and Scheduling will be kept to a minimum. For further information, contact Dan Gonzales, MATCA, 54667.

Signed

JEROME P. KLAR
Chief, Engineering and Planning Branch
Technology Repair Division
Directorate of Maintenance

1 Atch
Card Diagram

ENGINEERING NOTES

EMPLOYEE [illegible] DATE 9/5/90 PAGE NO. 89

RCC [illegible] SUBJECT Work Sampling meeting

9/5/90 -

I had asked Mr. Vroman and Mr. Gardner to meet with Danny Gonzales to discuss various modeling issues which now face us. We all met at 9:30 this morning, and Ms. Schattle was also present. While some modeling issues were discussed, there was discussion of engineering assessment and parts tracking as well. We discussed my plans for using log books to capture process times, and the manner in which we would use the data from the blue tracking tags to obtain IN and OUT times. I mentioned that we would need to exercise care in using the tracking data as direct model inputs, as this data would contain actual process queues (such as batching times, process mandatory flows, etc.) which we would expect the model to simulate. Direct input could therefor lead to exaggerated flow times.

After Mr. Gardner left, Ms. Schattle reminded us pointedly that we needed to obtain model input data as quickly as possible, her emphasis being on the data we are collecting from the work sampling effort. She was quite adamant on this, and left me with the distinct impression that she felt that our efforts in this area were lacking. She further stated that Mr. Gonzales also felt that we were not performing to their levels of expectations in this area.

I am a little confused by these turn of events. We did not receive the parts tags until yesterday evening, and the formal notification letter was not provided by the ALC administration until yesterday morning. I was also under the impression, wrongly I now understand, that Mr. Gonzales was going to be responsible for contacting many of the floor and support personnel about our tagging efforts. Since these efforts have all fallen to Mr. Premo and I, our job has been seriously complicated. I have no problem with undertaking the extra workload, and I do understand their concerns

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ENGINEERING NOTES

EMPLOYEE Parker
DATE 9/6
PAGE NO. 85
RCC MAT/SI
SUBJECT work sampling meeting

for the timely completion of this task order, but I would prefer a little more reasonableness in these matters. I was given to understand that both Ms. Schattle and Mr. Gonzales felt that I could have done more in preparing for this effort, and perhaps should have already had it in operation. I would like to point out that it would be somewhat difficult for a contractor to show up in a production chief's or scheduling chief's office and announce such an undertaking without proper approval letters in hand. I would also like to point out that MDMSC personnel, when informed of the request that we undertake parts tracking (on 8/16/90, a full month after the task order began), have performed almost every aspect of realizing this request to date. This has included identification of many of the items to be tracked, structuring the methodology to be used, identifying the collection nodes. and actively assisting in selling the concept to MAT and MAE management personnel. If we are now to be criticized for not having undertaken the tagging of parts earlier, I would like to point out that we are now expected to individually contact each and every production foreman, scheduler, and material handler who would be effected by this undertaking, as well as pay the necessary courtesy visits to the various RCC management personnel. Until this is done (and I maintain that it would be impossible to have done it before we had the formal permission letter in hand) it would be a waste of effort to begin the physical tagging of parts.

I was again unable to meet with Mr. Perez to discuss the parts tracking efforts. If I can not obtain a meeting with him by tomorrow morning, I will have to contact his supervisor, as it is critical to obtain the cooperation of the material handlers and the parts pool personnel at this time.

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ENGINEERING NOTES

EMPLOYEE Parker DATE 9/6/90 PAGE NO. 86

RCC MPTPSE SUBJECT work Sampling

9/6/90 -

I met with Mr. Perez this morning to discuss parts tagging and the role his personnel (material handlers, parts pool) would have in this effort. Mr. Perez was very helpful, and we agreed to get together at noon for a tour of the parts pool and a discussion of the kitting operation.

After speaking to Mr. Perez, I went to the both the GTE final assembly and the final testing areas. After discussions with the shop foremen of these areas (Mr. Somora and Mr. Vaquera respectively), I have determined that it would probably be unproductive to attempt to log items in these areas. The parts required to build a GTE are delivered in Kit form to final assembly, and the number of GTEs produced is predetermined for the month. The actual assembly time is also fairly constant, although some variation can exist due to alignment and fit problems. I am afraid that we would not be able to obtain a clear picture of the assembly times in this area using the log book technique, especially since there are no -397 engines scheduled out this month. Likewise, the test times for the finished products are relatively fixed, and the variation which occurs due to rejects is best determined, in my opinion, by interview and use of the shop's log book. I would also point out that the labor standards for these areas are fairly well developed, and should serve as a good reference and check on any interview data obtained.

Mr. Gardner, Mr. Premo, and I went back for our appointment with Mr. Perez this afternoon. The discussion was informative. We were shown how kit shortages are displayed on tags attached to the kitting baskets, as well as how parts are delivered to the area, and then sorted into kits. We also discussed the relatively frequent occurrence of parts shortages, and the procedures used to handle

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ENGINEERING NOTES

EMPLOYEE P Parker DATE 7/6/92 PAGE NO. 87

RCC MATRS I SUBJECT Work Sampling

these. Mr. Perez agreed to log all parts entering the parts pool which have been tagged and are being tracked in our effort. He also agreed to have the material handlers under his supervision log items in and out of the various RCCs.

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ENGINEERING NOTES

EMPLOYEE Parker
DATE 9-7-90
PAGE NO. 88
RCC MATPSI
SUBJECT Work Sampling

9/7/90 -

I met with Mr. Mosman this morning, who is responsible for scheduling operations in both MAEPNC and MAEIAA. He also is charged with these duties in MAEPDB. Mr. Mosman pledged support for this effort, and introduced me to Mr. Tendall and Mr. Gilbert, who are responsible for the shop scheduling and material handling practices in these areas. Mr. Premo and I met with these gentlemen, and discussed what we would be doing. They both agreed to cooperate with our efforts.

Mr. Gardner, Mr. Premo, and I also met today with Mr. Negben, who is the MATPSI section chief. Also present was Mr. Gonzales, and Mr. Albert Musquiz and Gilbert Torres, who are foremen in the inspection and cleaning areas respectively. We discussed the manner in which we would track parts in these areas, as well as how we would capture actual process times. We also discussed the new cleaning line, as well as the use of Cold Jet cryogenic blasting techniques in this area. We obtained good support for the tagging effort, and there were several excellent suggestions from the production personnel as to the best way to track items traveling to the MAEPNC cleaning line. As these parts are all sent in large modules with no item by item handling, it was decided to tag the paperwork accompanying the module. As I mentioned above, Mr. Mosman's people have already been notified.

There was some interest expressed about our mention of Cold Jet. MATPSI personnel agreed to provide us with various items requiring cleaning which could be taken to the Cold Jet facility for processing and testing. To be fair, I should mention that I broached this subject with Mr. Kiker earlier, and he was less than enthused with the idea. He did not have problems with the technology, but rather was skeptical that funding could be obtained, especially given

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ENGINEERING NOTES

EMPLOYEE Parker DATE 9/7/90 PAGE NO. 89

RCC [illegible]

SUBJECT [illegible]

his experiences with the new cleaning line. I sympathize, but I should point out that any process which has the potential of reducing environmental contaminants is worthy of study. We will pursue this line of inquiry, and present our recommendations at a later time.

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ENGINEERING NOTES

EMPLOYEE Parker DATE 9/10/90 PAGE NO. 90

RCC MATPSI SUBJECT Work Sampling

9/10/90 -

Ken Premo has taken responsibility for parts tracking in MATPSI cleaning and inspection, MATPNN welding, MAEPDB heat treat, and MAEIAA flouride ion cleaning. Mr. Premo is in the process of tagging items in these areas at this time. I will be responsible for tracking parts in both the machine shop and the plating facility.

This morning I met with Mr. Gilbert, the scheduler in MAEIAA. Mr. Gilbert explained routing procedures for his area, as well as how these interact with machine shop functions. We discussed his role in the tracking of parts in the plating shop, which was somewhat involved. I am hoping that this will not prove to be too much of a burden on Mr. Gilbert's daily routine, as he is the only scheduler for this area, and appeared quite well utilized. He struck me as a very conscientious person, and I am confident he will do his best for us in these matters.

I spoke with Mr. Sanchez, who is the administrator of the machine shop. He was very supportive of the parts tracking idea. Mr. Sanchez also talked about some of his experiences in working with the GTE process over the last several years, which was very informative. I also attempted to meet with Mr. Richard Garcia, who is the scheduling chief for the machine shop. He was on sick leave, and I went ahead and called Mr. Ynostrosa, who is in charge of the material handlers for this area. We are to meet at 10:00 AM tomorrow.

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ENGINEERING NOTES

EMPLOYEE Parker DATE 9/11/90 PAGE NO. 91

RCC MATPSI SUBJECT Work Sampling

9/11/90 -

I met with Mr. Ynostrosa this morning. He was quite displeased with the idea of tracking parts, and was very vocal about his concerns that the requirements to log parts in and out of the RCC was going to create a hardship on the material handlers. I felt that it would be better to let him vent this displeasure, rather than just try to mandate his cooperation. (We already had obtained his branch chief's permission, as well as the permission letter which I showed him). I spent nearly two hours discussing this subject with Mr. Ynostrosa, and I feel confident that he will cooperate in our efforts. I requested that he allow me to ride with his parts expediter/material handlers to get a better idea of how much actual work was involved. He was quite happy that I do so, as he felt I would be overwhelmed with the amount of work that our parts tracking would entail. In actuality, I was simply interested in learning the parts routing procedures his people use. It did not seem politic to mention this fact. I will meet with his people at 6:45 AM Thursday morning.

I met with Mr. Moore this afternoon. Mr. Moore is the branch chief in the plating area, and he also pledged his support for the parts tracking effort. We had met with Mr. Moore earlier last month, and he had expressed reservations. He still feels that we would have more success with interview data than with logging parts as they actually enter the plating process. He refered me to Mr. Kneapper, who is the first line supervisor for the area. Mr. Kneapper and I discussed the matter, and he felt it would be very difficult to log the items into a book at the beginning of the process. This is due to the variability of the plating processes used, the various mandatory dwell times involved, and diverse workload/prioritization considerations. We agreed to modify our efforts in this RCC, and he

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ENGINEERING NOTES

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RCC MATPST SUBJECT Work Sampling

will alert his people to document process times for the length of this study.

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE 9/12/90 PAGE NO. 93

RCC [illegible] SUBJECT Work Sampling

9/12/90 -

I obtained both the overall WCD as well as the high level stats for the 1st stage compressor inlet housing from Susan Randolph this morning. These will be helpful in our efforts to study this critical part.

I spent most of the day walking through the various GTE process areas, attempting to get a better idea of how parts are routed back and forth between the process centers. My initial impression is that the backshops, perhaps because of their diverse workloads, are more well structured in there routing and material handling practices than are those found in bld. 329 itself.

I also spent some time updating model files, especially item and operation profiles. I updated the historical documentation of our spreadsheet files at the same time.

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ENGINEERING NOTES

EMPLOYEE Parker DATE 9/13/90 PAGE NO. 91

RCC MATPST SUBJECT [illegible]

9/13/90 -

I rode around with the machine shop material handler this morning. It was extremely informative. The flow into and out of the machine shop is well regulated, with pickups and deliveries made on a regular basis. The incoming and outgoing points are clearly marked and logically organized, and most WIP is neatly contained on various metal racks bordering the work areas. I was also shown where items are delivered and picked up in the plating area, as well parts pool in bld. 329. I would suggest that there are several areas in bld. 329 which could benefit from this structured routing system, and I will discuss these in more detail at a later time.

Mr. Gardner and I met with Pete Garza, Susan Schattle, and the two ALC task order leaders this afternoon. We discussed various items of interest and concern that they had. For the most part, it was decided that MDMSC/ALC personnel need better communication, and our ALC teammates took most of the action items required to accomplish this. We agreed to be more available with our daily and weekly objectives, as well as communicating these to our task order leaders. I feel as though we have always done this to some extent in the GTE area, but I admit that improved communications is always a worthy goal. The most important point to come from this meeting was the allowing of interviewing in certain areas of the GTE repair processes. Work sampling/parts tracking will continue unabated. I was very grateful to Mr. Gonzales for this, as it will greatly assist my efforts to structure the operation profiles for the model.

9/14/90 -

I spent today performing the parts tracking tasks in machine shop and plating, as well as contacting the various supervisors to set up interviewing for next week. I also assisted Mr. Premo with

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ENGINEERING NOTES

EMPLOYEE [illegible]
DATE [illegible]
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RCC [illegible]
SUBJECT [illegible]

his parts tagging, as I feel that it is important that we each are familiar with all aspects of the parts tracking efforts.

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ENGINEERING NOTES

EMPLOYEE Premo DATE 9-30-90 PAGE NO. 1

RCC = SUBJECT PARTS TRACKING

At the request of Danny Gonzales parts tracking was initiated for a selection of GTE parts. The purpose of the tracking was to establish the flow times of the parts both within and between RCC's that are involved in the GTE repair process. The parts tracking is being accomplished by stapling blue tags to the WCDs that follow the parts through the system as they are required. In and out dates and times are recorded onto the tags by parts handlers as the parts move through the system. This information is then recovered either by visual inspection of the tags or removal of the tag when it reaches the parts pool. Following is a list of the parts that are being tracked and the total number of each that have been tagged in MATPSI, MATPNN, MAEPDB, MAEIAA (building 339) by 9-29-90:

397 COMPRESSOR HOUSING	14
397 DESWIRL	26
397 2ND STAGE DIFFUSER	24
397 1ST STAGE COMPRESSOR INLET	17
397 TURBINE NOZZLE	33
397 BEARING HOUSING	49
397 ACCESSORY CASE	8
180 2ND STAGE COMPRESSOR HOUSING	40
180 1ST STAGE INLET	24
180 1ST STAGE COMPRESSOR DIFFUSER	24
180 2ND STAGE DIFFUSER HOUSING	7
180 2ND STAGE COMPRESSOR DIFFUSER	4
180 TURBINE NOZZLE	13
180 TURBINE [illegible]	39
180 COMBUSTION LINER	43
180 BEARING HOUSING	30
180 WHEEL AND SHAFT ASSEMBLY	16

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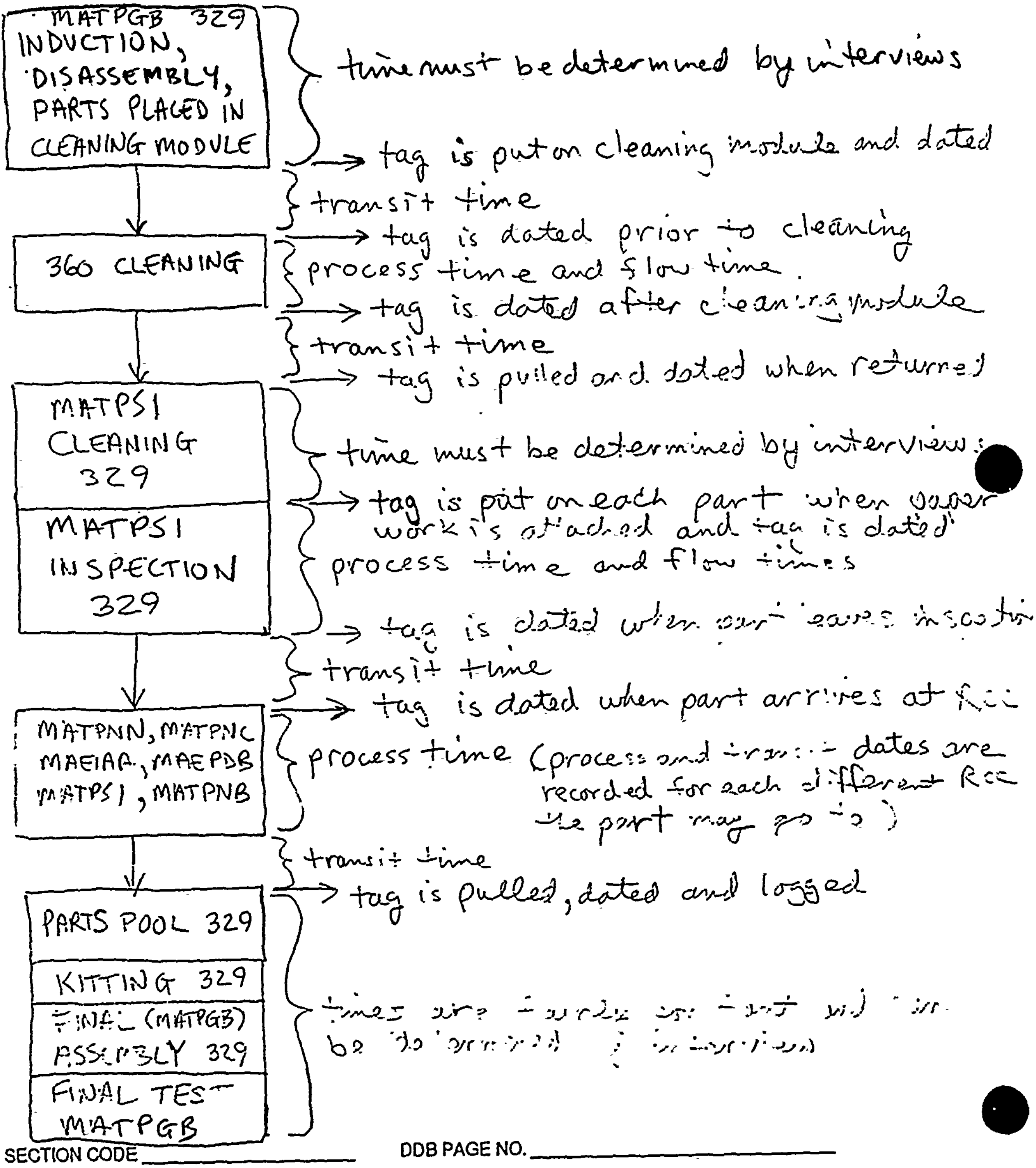
ENGINEERING NOTES

EMPLOYEE Premo DATE 9-30-90 PAGE NO. 21

RCC ______ SUBJECT PARTS TRACKING

Following is a schematic of the GTE repair process and the various ways data will be collected in the tracking effort:



time must be determined by interviews

→ tag is put on cleaning module and dated

transit time

→ tag is dated prior to cleaning

process time and flow time.

→ tag is dated after cleaning module

transit time

→ tag is pulled and dated when returned

time must be determined by interviews

→ tag is put on each part when paper work is attached and tag is dated

process time and flow times

→ tag is dated when part leaves inspection

transit time

→ tag is dated when part arrives at RCC

process time (process and transit dates are recorded for each different RCC the part may go to)

transit time

→ tag is pulled, dated and logged

times are [illegible] be determined by interviews

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ENGINEERING NOTES

EMPLOYEE Premo DATE 9-30-90 PAGE NO. 31

RCC SUBJECT PARTS TRACKING

Interview times will have to be used during the induction and disassembly phase of the process because it is difficult to tag the parts of the engine prior to the point where paper work is assigned to each individual part (after the cleaning process is complete). Similarly, interview times will be required for the assembly of cleaning modules (prior to cleaning in 360) and for the hand cleaning process in MATPS1. It will be possible to capture some of the time during the period of time when the parts are sent to building 360 to go through the cleaning line. Modules are being tagged and dated prior to leaving MATPGB and the tags are dated and removed when the modules arrive at MATPS1 after cleaning in 360. Once cleaning is done in MATPS1 parts are moved immediately into the staging area of MATPS1. In this area the parts are given a madatory 24 hour acclimation wait until their temperature reaches that of the inspection room. During this time the parts are given FPI, are identified, and are assigned paper work. The parts are then moved into the main inspection area via a conveyor. At this point it is possible to start the individual tagging of parts. In addition to the tagging of the WCD's to capture flow times between and within RCC's, an attempt is being made to capture the queue times, hands on process time, and wait time within each area. To this end log books have been distributed to the foreman or front line supervisors in

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EMPLOYEE Premo
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RCC
SUBJECT PARTS TRACKING

each area. Each supervisor has been asked to log the time and date when his workers first start to work a tagged part and the time and date when the work is completed. this data will be used in conjunction with the WCD tags to figure the queue times and wait times for each process. In those areas where it was impractical for the supervisors to fill out the log book, instructions have been given to the workers so that they can fill out the log book themselves. While this may open up the opportunity for the workers to "fudge" some numbers, it is the only way to get the logs filled out in areas where the supervisor is not directly involved with every detail of the assignment of work. In these areas, workers are allowed to select and process their work without involvement of the supervisor. Log books have been given to supervisors in MATPS1 inspection and parts pool, MAEAA [illegible] in cleaning, MAEFF plating shop, MATPNN, and MAEPDS heat treat.

After a part leaves MATPS1 inspection it is routed to various backshops or directly to parts pool depending upon its condition and repairs that are required. Each time a part moves from one RCC to another in and out dates will be recorded on the parts tags and hands on work start and stop times and dates will be recorded into the log books (hopefully). After all work is completed on a given part it is routed to MATPS1 parts pool. At this time the

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RCC SUBJECT PARTS TRACKING

parts tracking tag is removed and the in date and tag number are entered into a log book. At this time there is no attempt to track the amount of time a part actually sits in the parts pool. This is not required because parts are added to a pool of floating stock once they enter the parts pool area. Parts are removed from the floating stock and put into complete engine kits. This kitting operation is done on a demand basis which is governed by the schedule of engines to be completed. Parts pool is given a monthly quata of kits for each type of engine and only produces what is required. Thus, flow of parts through the parts pool will be the same as that determined by scheduling (provided a sufficient suppy of parts from backshops). When an engine kit is routed to MATPGB final assembly from the parts pool, an engine number is assigned and all the WCDs related to the parts are consolidated into one pack that travels with the parts. Scheduling keeps a log book in which the assigned serial number and date for each delivered kit is recorded. Later, when an engine passes final test, the final sell date is entered into the log book. This is a good way to determine the flow time from the kitting area to final sell. Because of a shortage of storage space in final assembly, parts pool tries to keep a head of final assembly by one day. According to Bill Hunt who is a supervisor in final assembly, assembly time for an

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RCC

SUBJECT PARTS TAGGING

engine is fairly constant. It takes about 8 Hours to build an engine from a kit. Once an engine is completed it is routed to final test. The engines are tested using an automated test stand. Test times are usually constant unless problems are encountered or the engine fails. If an engine cannot pass on the stand, an attempt is made to "fix" the problem without removing it. The cause of the failure is determined and the engine is removed and sent back to final assembly for repairs if it can be repaired easily on the test stand. This process is repeated until the engine passes final test.

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RCC SUBJECT PARTS TAGGING

Following are general observations and opinions related to the parts tracking effort.

- While all supervisors and workers agreed to cooperate with the parts tagging effort, some did so reluctantly. Some objected to the extra work that it would require and the impact it might have on production. In my opinion there appears to be an atmosphere of mistrust and fear associated with the parts tagging and touch time logging. This is not surprising, however, considering the recent talk of budget cuts, RIFs, and the current reorginization of the ALC. Hopefully this will not have a serious effect on the results of the tracking.

- In my opinion the enacting of a parts tracking effort at this time is making many of the RCC's which are involved in the process feel as if they are "being watched". This is causing them to expedite tagged parts through their areas. Obviously, if they are given the choice between working a tagged item and an untagged item they will choose a tagged item. Nobody wants to be labled a bottleneck at this uncertain time. Unusually short flow times may result from this special treatment of the tagged items. Historical WCD data shows considerably longer flow times than those that are appearing on the tags of the tracked parts.

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RCC

SUBJECT PARTS TRACKING

- Not all tags are being marked properly as the parts are moved through the system. It appears that this is caused by several factors. Some tags are simply not seen by the parts handlers as the move the parts one RCC to another. This can happen when a blue tag has been folded up inside of an WCD and thus hidden from view. This problem is difficult to prevent. Another possible cause of the missed tags is related to the way in which parts are routed. Because parts are often done in batches by the RCC's they are often placed in tubs together with like parts with the same destination. The routing for the tub of parts is then written in black marker on a piece of masking tape which is attached to the rim of the tub. Often two tubs are stacked if they have a common destination. This stacking of the tubs effectively "hides" the parts that are in the bottom tub. If items in the bottom tub are tagged the parts handler will not see them. Because some of the tubs are quite heavy it is unlikely for a parts handler to pick up a tub to look for tagged items. This is especially true if the destination is written on the tub, which eliminates the need for the parts handler to look at individual WCDs in order to determine routing. This method of routing parts helps to make the parts handlers job easier, but contributes to missed tags and misrouting.

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RCC ______ SUBJECT PARTS TRACKING

- Parts tracking appears to be validating the use of historical WCD data as a source of flow time data. Visual inspection of marked tags indicates that in almost all cases the out date marked by the parts handlers as they move parts between RCC's exactly matches the last stamp date on the WCD. This is true because the parts handlers generally do a good job of moving parts once they are placed in the outgoing pickup areas of the RCCs. It also indicates that parts are swiftly moved out of an RCC once work is completed by the workers. This makes sense; there is no reason for a shop to store up parts in their area once they are completed. This is especially true when you consider that most of their storage space is used up by parts waiting to be worked. In general, most parts are moved to the next shop within 0-1 days after they are completed by a shop (based upon visual inspection of WCD's and marked tags). This indicates that most of the flow time consists of time spent waiting to be worked. Actual hands on process times are very short compared to overall flow times.

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RCC

SUBJECT RCC DATA

Following are brief descriptions of many of the RCCs that are involved in the GTE repair process. More complete data will be obtained and documented after interviews are completed during the week of 10-1-90.

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RCC ____________ SUBJECT MATPGB

Disassembly - building 329

Supervisor - Alex Perez 5-9720

manpower - 9 total 1shift

(2) wg's helpers, uncrating, routing
(1) wg 9
(6) wg 10's teardown

OT - none really (info from B. Hunt)

Function -

- induct engines (and log)
- disassemble engines
- take parts and load modules for cleaning
- route modules to cleaning.

Tagging

- engines can't be tagged prior to disassembly.
- completed modules are tagged at completion
- ~~date~~ is logged when modules are placed at pick up point
- Adolf Leal, 5-9720 builds the modules and applies tags
- module tags will be dated when received into 360 cleaning
- tags date when routed out of 360
- tags ~~#~~ dated and removed when received by MATPS1 cleaning

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RCC ____ SUBJECT MATPS I

Cleaning bld 329

- Gilbert Torres, supervisor 5-5749
- manpower 1 shift, (11) Wg 5's

OT. ⇒ 20hrs/wk random occurance (surge)

Function

- re clean parts after they come back from cleaning (bld. 360)
- often cleaning is inadequate (360)
- low priority causes some delays
- mainly hand cleaning, sandblasting, plastic media blasting
- putting in their own cleaning line -- in order to overcome poor cleaning and time delays due to low priority in bld 360

Tagging • parts are not tagged in cleaning

- tags removed when modules return from 360 time and date is logged at the time when the module is "broken" open.
- parts are then cleaned and sent to FSI inspection where they ~~or~~ receive their paper work and are inspected

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ENGINEERING NOTES

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RCC
SUBJECT MATISI

Inspection bld 329

Supervisor — Albert Musquiz 5-3539

manpower — 15 total — 4 on loan, 1 in FPI

(5) Wg 10's — can do eddie current (not done however)
(10) Wg 9's

all do basically the same inspections

Function.

- Visually and dimensionally inspect parts.

parts flow.

- parts are move directly in the inspection area to a holding room where the are given 24 hrs to acclimate to room temp. Parts are identified and an initial WCD is attached. Parts undergo FPI.
- Parts are then moved into the main inspection area where they are given a dimensional inspection.
- moved out on conveyor after insp.
- parts picked up by parts handlers outside on a conveyor belt

Tagging - parts are tagged imediately after FPI and paperwork is attached or after inspection, prior to pick and routing

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RCC ____________ SUBJECT MATPSI

parts pool bld 329

Supervisor - Mr. Ferez

Function - • move parts through systems
• collect parts and put them into kits
• distribute parts to final assembly

parts flow -

- responsible for parts handling within MATPSI and between MATPSI and other RCC's (backshops)
- once parts are serviceable they are routed to the parts pool where they are put into kits.
- Kitting is dependent upon the scheduled demand for engines (ie kits are put together for only those engines that are to be built that month). Extra parts remain on shelves until they are needed.

Tagging

- tags are removed when parts arrive at the parts pool.
- in dates are logged at that time,

Manpower (5) WG 7's 1 shift

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(4) moving parts?

OT sporatic
1 wk/month (20hrs)

ENGINEERING NOTES

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RCC ________ SUBJECT MMTPGB

Assembly - building 329

Supervisor - Bill Hunt 5-3597

Function - • receive parts from parts pool and build engines
- balance rotating assemblys
- route completed engines to final test
- rework rejected engines until they pass final test.

Manpower - 15 total workers, 1 shift
OT ⇒ 1 wk/month 4 hrs/day + saturday 8 hrs
= 28 hrs/month

(2) wg 10's
(13) wg 9's ← apx 5 of these work in spin balance

Tagging -
- no tagging done at this stage of the process
- time to assemble is relatively constant. (1 day)
- paper work is removed from the idividual parts during kitting
- scheduling keeps a log of when kits are delivered to final assembly from the parts pool.

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RCC ______ SUBJECT MAEPDB

Heat Treat building 324

Supervisor – Norbert Kyrisch

Function –

- Heat treat, braze, shot peen, stress relieve parts from engines, airframes, and GTE's
- GTE's have low priority because MAEPDB is part of engines.

Flow of Parts

- GTE parts are picked up and received at a centralized location (B33), bld 324
- because of low priority, some GTE parts may have long flow times through MAEPDB. Also, batching increases flow times
- Three basic processes are used on GTE parts:
  - low temperature stress relieving of aluminum parts in small atmospheric ovens.
  - higher temp heat treating of steel parts in larger vaccuum furnaces.
  - shot peening of steel parts for stress relieving and preparation for plating.

Tagging

- parts are tagged both before and after heat treating at station B33
- relatively few parts have been in MAEPDB to date.

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ENGINEERING NOTES

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RCC ____ SUBJECT MAEIAA (339)

Floride ion cleaning - building 339

Supervisor - David Alonzo

Function - special section of plating that applies special coating and performs floride ion cleaning (FIC) on 397 turbine nozzles prior to nickel braze

Manpower - 2 workers Wg ?'s

Tagging

- parts can be tagged prior to and after cleaning
- long wait time prior to processing because
- process must be done in batches of 10-15 nozzles because of excessive cost and environmental concerns.
- extremely complex machine is prone to breakdowns
- during the tagging the FIC machine broke down on two different batches of parts. The first breakdown was due to a bad solenoid valve and the second was due to a crack.
- lack of spare parts causes long delays and down times
- It is unlikely that accurate tracking data will be obtained due to the recent breakdowns of the FIC machine.
- Historical data may need to be utilized

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ENGINEERING NOTES

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RCC ________ SUBJECT MATPNN

MATPNN - bld 324

Supervisor - Homer Brooks 5-3388

Function - This RCC is divided up by function into 4 differerent sections. Following is a list of the sections and their respective parts pickup and drop off points.

Welding	b-25
Sheet Metal	b-23
Metalizing	b-20
Electron beam welding	b-19

- GTE parts have higher priority in this back shop compared to MAEPDB and MAEAF.
- GTE parts are often routed to this backshop:

[illegible]

PARTS tagging

- parts are tagged prior to and after they are worked by MATPNN.

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IPI EXPERIMENTATION

1) Reduce WIP. What effect would a reduction in WIP cause on throughput?

   a. Accelerate WIP and analyze the effect on production.

   b. Increase WIP and analyze the effect on production.

   c. For Phil: calculate WIP($ amount)

√ 2) Reduce manpower by 5, 10, 15, and 20%.

   a. What adverse effect does this have on throughput?

   b. What adverse effect does this have on flowtime?

√ 3) Simulate Surge Conditions.

   a. Increase GTE demand by 25, 50, 75, 100%.

   b. Increase # of shifts(PSI, PGB, PNC)

C 4) How will the Short Stack tranfer to B329 effect throughput?

√ 5) Reduce the GTE rejection rate.

   a. Reduce GTE rejection rates in 2% increments and analyze the effect on production.

6) Reduce the Sub/Final assembly rejection rate.

   a. Reduce machine shop rejected items in 2% increments and analyze its effect on production.

C 7) GTE Inductions.

   a. Vary the GTE induction rate : - constant inductions
   - once a month

* A detailed analysis of each experimentation run and associated savings is required.

EXPERIMENTATION TAGUCHI SET UP

GTE experimentation consisted of the taguchi array $^{L(4)}L(9)$. This is an L(9) inner array with an L(4) outer array. 36 runs are needed for the experimentation [L(9) * L(4)]. Two seeds were used for each experiment and the results averaged for a total of 72 runs.

The L(9) array consists of 4 factors at 3 levels each. The factors and levels are:

Factor L(9) 1: Manpower

Level 1:	As Is
Level 2:	Decrease by 10%
Level 3:	Decrease by 20%

Factor L(9) 2: Workload

Level 1:	As Is
Level 2:	Increase by 50%
Level 3:	Increase by 100%

Factor L(9) 3: Reject rate at final test

Level 1:	As Is
Level 2:	Decrease by 50% (to 12%)
Level 3:	Decrease by 100% (to 0%)

Factor L(9) 4: Work in Process - for GTE subcomponents

Level 1:	As Is
Level 2:	Create initial floating stock to 10% of average WIP
Level 3:	Create initial floating stock to 30% of average WIP

The L(4) array consists of 2 factors at 2 levels each. The factors and levels are:

Factor L(9) 1: Moving much of the bearing housing work in-house to GTE

Level 1:	As Is
Level 2:	Moving in house

Factor L(9) 2: Inductions

Level 1:	As Is in model-inductions randomly through the month.
Level 2:	Inducting all GTEs at day 1 of each month

EXPERIMENTATION - PRELIMINARY RESULTS

The following section describes the results shown by examining the inputs to and the outputs from experimentation:

BEARING HOUSING - Moving the bearing housing in-house makes sense because of the large amount of time the parts sit in backshops waiting to be worked. Moving the work in house can remove most of the waiting time since the part is now most worked under GTE control. The results effect flowtimes of the bearing housing, but not the overall GTE flow times because other subassemblies have longer flowtimes.

INDUCTIONS - Inducting the GTEs at the beginning of the month adds about 4 days to the flowtime, since there is a large number of GTEs at once waiting for disassembly [but excluding the time spent waiting for subassemblies, processing flowtime increases by about 40%]. It is better to spread the inductions over the course of the month. Weekly inductions would ease the strain on inducting large numbers at the beginning of the month.

MANPOWER - Manpower was reduced for in-house personnel in building 329. While the 10% reduction showed little effect , a 20% reduction shows an effect. Mainly the incoming inspectors are affected, since they are the highest utilized in the model.

WORKLOAD - Increasing the workload by 50% has little effect, but increasing it by 100% has a large effect. Again, the incoming inspectors are they bottleneck. If the workload were to increase above 50%, either the inspectors will have to inspect faster or their number should be increased. It appears from the historical data that personnel in the MATPNC area do much of the inspection of the parts anyway. If the workload were to increase, PNC may be able to formally share in the inspection of the parts.

REJECT RATE - Decreasing the reject rate improves the model flowtimes. The effect is small because the most of the flowtime for a GTE is spent waiting [in the model] for its subcomponents. While the effect in the model is small, the effect on the GTE production process would be large because of the scrambling that occurs at the end of every month to meet the monthly production goals.

WORK IN PROCESS - Finished subcomponents were put into the model to show the effect of overinducting GTEs so that a "good" part can be stripped off a GTE in order to put on a GTE that is almost ready to be sold. The effect is to reduce the overall flowtime for a GTE, but to increase the overall number of subcomponents in the model. When over-induction occurs over a large period of time, a large amount of work in process occurs.

SUMMARY

Much of the effects from experimentation were obscured by the fact that most of the flowtime for a subcomponent is spent sitting idle. Less than 5% of the time is needed for processing. Most of the idle time is spent in backshops that GTE has no control over. The historical data suggests that the excessive flowtimes are due to a lack of coordination arising from a part travelling all over the base to many different backshops rather than waiting for busy equipment or manpower. Since the backshops service a large number of customers [often with the GTE workload a small part of their entire workload], they have little incentive to produce the needed parts in a timely matter.

Moving the work in-house to the GTE area would provide GTE control over the process and would reduce the subassembly flowtimes drastically [an estimated reduction of 60-85%]. Most of the large current WIP would not be needed to support monthly production and over-inductions in order to meet production goals would not be needed if the work was performed in-house in building 329.

If the manpower and machines currently being used in the backshops were to be transferred to GTEs, the only additional cost would be the moving cost. As much of the work as possible should be moved in house. An informal JIT-pull system currently exists [supervisors try to "pull" critical parts out of the backshop], but a more formal one could be set up if more of the work were to performed in-house.

An automated part tracking system would greatly aid in the management of the in-house work, since problem areas could be identified quickly [areas where critical parts are waiting] and management would have the ability to resolve the problems. For the same reasons an automated part tracking system would greatly aid in the management of the current in-house work.

Currently inductions are such that a large number of GTEs are disassembled at the beginning of the month, and a large number are assembled and sold at the end of the month. This results in manpower and equipment that is highly utilized part of the time and idle the much of the time. Inducting GTEs on a weekly schedule and selling them on a weekly schedule would smooth the demand on resources and increase production [rather than being idle due to a lack of work at the beginning of the month, personnel could be working on selling GTEs.

Smoothing inductions and sells, bring work in-house and adding an automated part tracking system could increase GTE production by 20-30% and quality by 40%.

GTE $L_9\ ^{L_4}$

	L_4 1	L_4 2	L_9 1	L_9 2	L_9 3	L_9 4
Exp #	Bearing hsg.	Inductions	Manpower	Workload	Reject rate	WIP
1) 1,1	As Is	As Is	As Is	As Is	As Is	As Is
2) 2,1	As Is	As Is	As Is	+50%	-12%	+10%FS
3) 3,1	As Is	As Is	As Is	+100%	0%	+30%FS
4) 4,1	As Is	As Is	-10%	As Is	-12%	+30%
5) 5,1	As Is	As Is	-10%	+50%	0%	As Is
6) 6,1	As Is	As Is	-10%	+100%	As Is	+10%
7) 7,1	As Is	As Is	-20%	As Is	0%	+10%
8) 8,1	As Is	As Is	-20%	+50%	As Is	+30%
9) 9,1	As Is	As Is	-20%	+100%	-12%	As Is
10) 1,2	As Is	Monthly	As Is	As Is	As Is	As Is
11) 2,2	As Is	Monthly	As Is	+50%	-12%	+10%
12) 3,2	As Is	Monthly	As Is	+100%	0%	+30%
13) 4,2	As Is	Monthly	-10%	As Is	-12%	+30%
14) 5,2	As Is	Monthly	-10%	+50%	0%	As Is
15) 6,2	As Is	Monthly	-10%	+100%	As Is	+10%
16) 7,2	As Is	Monthly	-20%	As Is	0%	+10%
17) 8,2	As Is	Monthly	-20%	+50%	As Is	+30%
18) 9,2	As Is	Monthly	-20%	+100%	-12%	As Is

575

GTE $L_9^{L_4}$

Exp #	L4 1 Short Stack	L4 2 Inductions	Lg 1 Manpower	Lg 2 Workload	Lg 3 Reject rate	Lg 4 WIP
19) 1,3	B329	As Is	As Is	As Is	As Is	As Is
20) 2,3	B329	As Is	As Is	+50%	-12%	+10%
21) 3,3	B329	As Is	As Is	+100%	0%	+30%
22) 4,3	B329	As Is	-10%	As Is	-12%	+30%
23) 5,3	B329	As Is	-10%	+50%	0%	As Is
24) 6,3	B329	As Is	-10%	+100%	As Is	+10%
25) 7,3	B329	As Is	-20%	As Is	0%	+10%
26) 8,3	B329	As Is	-20%	+50%	As Is	+30%
27) 9,3	B329	As Is	-20%	+100%	-12%	As Is
28) 1,4	B329	Monthly	As Is	As Is	As Is	As Is
29) 2,4	B329	Monthly	As Is	+50%	-12%	+10%
30) 3,4	B329	Monthly	As Is	+100%	0%	+30%
31) 4,4	B329	Monthly	-10%	As Is	-12%	+30%
32) 5,4	B329	Monthly	-10%	+50%	0%	As Is
33) 6,4	B329	Monthly	-10%	+100%	As Is	+10%
34) 7,4	B329	Monthly	-20%	As Is	0%	+10%
35) 8,4	B329	Monthly	-20%	+50%	As Is	+30%
36) 9,4	B329	Monthly	-20%	+100%	-12%	As Is

EXP ALL SUMMARY

BEARING HOUSING

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Bearing factor -> ITEM NAME	FLOW TIME AS IS	 B329	THROUGHPUT AS IS	 B329	AVE WIP AS IS	 B329
1ST.STG.COMPR.DIFF	40	41	1	1.00	12	12.1
1ST.STG.INLETASSY.	65	64	1	1.00	19	18.9
2ND.STG.COMPR.DIFF	74	74	1	0.99	22	21.7
2ND.STG.DIFF.ASSY	136	137	1	1.01	74	74.7
2ND.STG.DIFF.HSG.	86	87	1	1.00	25	25.5
2NDSTG.COMPR.HSG.	97	96	1	1.00	29	28.3
ACCESSORY CASE	18	18	1	1.00	10	10.0
BACKSHOP 180	54	53	1	1.00	16	15.7
BACKSHOP 397	30	30	1	1.00	16	16.3
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
COMB. CHAMBER LNG.	30	30	1	0.99	9	8.8
COMPRESSOR INLET	69	68	1	0.99	37	37.3
GTE -180	138	129	1	0.86	43	40.9
GTE -397	149	149	1	0.89	85	84.8
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
TORUS TURBINE	43	43	1	1.00	12	12.6
TURBINE BRG. HSG.	103	104	1	0.99	57	57.3
TURBINE NOZZLE 180	73	74	1	1.00	22	21.7
TURBINE NOZZLE 397	79	78	1	1.00	43	43.0
WHEEL&SHAFTASSY.	82	82	1	1.01	24	24.0
	0	0	0	0.00	0	0.0

EXP ALL SUMMARY

INDUCTIONS

Induction factor -> ITEM NAME	FLOW TIME AS IS	 Monthly	THROUGHPUT AS IS	 Monthly	AVE WIP AS IS	 Monthly
1ST.STG.COMPR.DIFF	41	41	0.99	1.01	11.8	12.0
1ST.STG.INLETASSY.	65	65	1.00	1.00	19.0	19.1
2ND.STG.COMPR.DIFF	74	74	1.00	1.00	21.8	21.7
2ND.STG.DIFF.ASSY	136	137	1.01	1.01	74.5	74.5
2ND.STG.DIFF.HSG.	88	85	1.00	1.00	25.9	25.1
2NDSTG.COMPR.HSG.	96	96	1.01	0.99	28.2	28.7
ACCESSORY CASE	18	19	1.00	1.00	10.0	10.1
BACKSHOP 180	54	53	1.00	1.00	15.7	15.8
BACKSHOP 397	30	30	1.01	1.00	16.3	16.1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
COMB. CHAMBER LNG.	30	30	0.98	1.00	8.7	8.9
COMPRESSOR INLET	68	69	1.00	1.00	37.2	37.3
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	88	91	0.85	0.86	30.9	31.6
MATPSI 397 ONLY	89	91	0.85	0.86	57.1	58.0
TORUS TURBINE	43	43	1.00	1.00	12.4	12.7
TURBINE BRG..HSG.	102	105	1.00	0.99	56.3	57.9
TURBINE NOZZLE 180	73	73	1.00	1.00	21.4	21.8
TURBINE NOZZLE 397	80	77	0.99	0.99	43.7	42.4
WHEEL&SHAFTASSY.	82	82	1.01	1.00	24.0	24.2

578

EXP ALL SUMMARY

EXPERIMENTION ANALYSIS
MANPOWER

	FLOW TIME			THROUGHPUT			AVE WIP		
Manpower factor ->	AS IS	-10%	-20%	AS IS	-10%	-20%	AS IS	-10%	-20%
ITEM NAME									
1ST.STG.COMPR.DIFF	41	41	41	1.00	1.00	0.99	11.9	11.9	12.0
1ST.STG.INLETASSY.	64	65	66	1.00	0.99	1.01	18.8	19.1	19.3
2ND.STG.COMPR.DIFF	74	75	73	1.00	1.00	0.99	21.6	22.0	21.6
2ND.STG.DIFF.ASSY	136	136	137	1.00	1.02	1.00	74.4	74.6	74.5
2ND.STG.DIFF.HSG.	87	86	88	1.00	1.01	1.00	25.7	25.1	25.6
2NDSTG.COMPR.HSG.	96	96	97	1.01	1.00	1.00	28.3	28.4	28.6
ACCESSORY CASE	18	18	18	1.00	1.00	1.00	10.0	10.1	10.1
BACKSHOP 180	54	53	53	1.00	1.00	1.00	15.8	15.7	15.7
BACKSHOP 397	30	30	29	1.00	1.00	1.01	16.1	16.5	16.0
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
COMB. CHAMBER LNG.	30	30	30	0.99	0.99	0.99	8.8	8.9	8.8
COMPRESSOR INLET	69	69	68	1.01	0.99	0.99	37.4	37.3	37.1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	69	81	119	0.90	0.87	0.79	23.3	28.4	41.5
MATPSI 397 ONLY	69	81	120	0.90	0.88	0.78	43.9	52.5	76.3
TORUS TURBINE	43	43	43	1.00	0.99	0.99	12.5	12.5	12.6
TURBINE BRG. HSG.	102	104	104	0.99	1.00	0.99	56.2	57.9	57.1
TURBINE NOZZLE 180	72	73	75	1.00	1.00	1.00	21.4	21.6	21.9
TURBINE NOZZLE 397	78	78	79	0.99	0.99	0.99	43.0	42.6	43.5
WHEEL&SHAFTASSY.	81	83	82	1.01	1.00	1.00	23.9	24.3	24.2

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EXP ALL SUMMARY

WORKLOAD

580

Workload factor ->	FLOW TIME AS IS	2	2	THROUGHPUT AS IS	1.50	2.00	AVE WIP AS IS	1.5	2.0
ITEM NAME									
1ST.STG.COMPR.DIFF	41	40	41	0.99	1.00	0.99	7.9	11.9	16.0
1ST.STG.INLETASSY.	65	64	65	0.99	1.00	1.00	12.5	19.3	25.4
2ND.STG.COMPR.DIFF	74	75	73	1.00	1.00	0.99	14.5	22.2	28.5
2ND.STG.DIFF.ASSY	137	137	136	1.02	1.01	1.00	49.4	75.0	99.0
2ND.STG.DIFF.HSG.	88	86	86	1.00	1.00	1.00	17.0	25.3	34.0
2NDSTG.COMPR.HSG.	95	96	97	1.01	0.99	1.01	18.6	28.6	38.2
ACCESSORY CASE	18	18	18	1.00	1.00	1.00	6.6	10.1	13.5
BACKSHOP 180	53	54	54	1.00	1.00	1.00	10.2	15.8	21.1
BACKSHOP 397	29	30	30	1.00	1.00	1.00	10.5	16.4	21.7
~~BEARING HSG.~~	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
COMB. CHAMBER LNG.	30	30	30	0.99	1.00	0.99	5.8	9.0	11.7
COMPRESSOR INLET	69	68	68	1.01	1.00	0.99	24.9	37.2	49.7
~~GTE 180~~	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	~~71.7~~
~~GTE 397~~	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MATPSI 180 ONLY	32	63	174	0.99	0.94	0.73	6.1	18.9	68.7
MATPSI 397 ONLY	32	64	174	1.00	0.94	0.72	11.5	35.0	126.2
TORUS TURBINE	43	43	43	0.99	0.99	1.00	8.3	12.7	16.6
TURBINE BRG. HSG.	104	104	102	1.01	0.99	0.99	38.1	57.8	75.4
TURBINE NOZZLE 180	75	72	73	1.00	1.00	1.00	14.6	21.5	28.8
TURBINE NOZZLE 397	80	79	77	0.98	1.01	0.99	29.0	43.2	56.9
WHEEL&SHAFTASSY.	84	81	81	1.01	1.00	1.01	16.3	24.1	32.0

EXP ALL SUMMARY

REJECT RATE

	FLOW TIME			THROUGHPUT			AVE WIP		
Reject factor ->	AS IS	0	0	AS IS	0.12	0.00	AS IS	0.1	0.0
ITEM NAME									
1ST.STG.COMPR.DIFF	41	41	40	1.00	0.99	1.00	12.0	12.0	11.8
1ST.STG.INLETASSY.	65	64	66	0.99	1.01	0.99	19.0	18.9	19.3
2ND.STG.COMPR.DIFF	75	74	73	1.00	0.99	1.00	22.1	21.8	21.4
2ND.STG.DIFF.ASSY	137	136	137	1.01	1.00	1.00	74.7	74.2	74.6
2ND.STG.DIFF.HSG.	86	88	86	0.99	1.00	1.02	25.3	25.9	25.2
2NDSTG.COMPR.HSG.	96	95	98	1.00	1.00	1.01	28.4	28.4	28.6
ACCESSORY CASE	18	19	18	1.00	1.00	1.00	10.0	10.1	10.0
BACKSHOP 180	54	53	53	1.00	1.00	1.00	15.8	15.7	15.8
BACKSHOP 397	30	30	30	1.00	1.00	1.01	16.5	16.0	16.0
[redacted]									
COMB. CHAMBER LNG.	30	30	30	0.99	0.99	0.99	8.7	8.9	8.8
COMPRESSOR INLET	69	68	69	0.99	1.00	1.00	37.7	36.6	37.5
GTE -180	136	142	122	0.84	0.85	0.91	42.2	46.7	37.3
GTE -397	150	156	141	0.88	0.85	0.94	83.9	92.5	78.4
[redacted]									
[redacted]									
TORUS TURBINE	43	43	43	1.00	1.00	0.99	12.5	12.4	12.6
TURBINE BRG. HSG.	104	103	104	0.99	0.99	1.00	57.6	56.9	56.7
TURBINE NOZZLE 180	71	75	74	1.01	1.00	0.99	20.9	22.1	21.9
TURBINE NOZZLE 397	79	77	80	0.99	0.99	1.00	43.1	42.7	43.5
WHEEL&SHAFTASSY.	82	83	82	1.01	1.00	1.00	24.0	24.4	24.0

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EXP ALL SUMMARY

WIP

582

	FLOW TIME			THROUGHPUT			AVE WIP		
WIP factor ->	AS IS	10%	30%	AS IS	10%	30%	AS IS	10%	30%
ITEM NAME									
1ST.STG.COMPR.DIFF	41	40	41	0.99	1.00	0.99	12.0	11.9	12.0
1ST.STG.INLETASSY.	65	65	64	0.99	1.00	1.01	19.2	19.0	19.0
2ND.STG.COMPR.DIFF	74	74	74	0.99	0.99	1.01	21.9	21.8	21.5
2ND.STG.DIFF.ASSY	136	137	136	1.00	1.01	1.01	74.4	74.4	74.5
2ND.STG.DIFF.HSG.	86	87	87	1.01	1.00	1.00	25.5	25.6	25.3
2NDSTG.COMPR.HSG.	97	97	95	1.01	1.01	0.99	28.5	28.5	28.4
ACCESSORY CASE	18	18	18	1.00	1.00	1.00	10.0	10.1	10.0
BACKSHOP 180	53	54	54	1.00	1.00	1.00	15.7	15.8	15.8
BACKSHOP 397	29	31	29	1.00	1.00	1.01	15.8	16.7	16.1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
COMB. CHAMBER LNG.	30	30	30	0.99	0.99	1.00	8.8	8.8	8.8
COMPRESSOR INLET	68	68	69	0.99	1.00	1.00	36.8	37.3	37.8
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	98	78	93	0.84	0.87	0.85	35.2	27.4	31.1
MATPSI 397 ONLY	98	78	93	0.83	0.88	0.85	64.6	50.7	57.4
TORUS TURBINE	43	43	43	0.99	1.00	1.00	12.6	12.4	12.5
TURBINE BRG. HSG.	104	104	102	1.00	1.00	0.99	57.4	57.3	56.5
TURBINE NOZZLE 180	73	74	73	0.99	1.00	1.01	22.0	21.7	21.3
TURBINE NOZZLE 397	78	78	79	0.99	0.99	1.00	43.2	42.7	43.3
WHEEL&SHAFTASSY.	82	82	82	1.01	1.01	1.00	24.2	24.1	24.1

GTE EXPERIMENTATION

TO 15

November, 1990

GTE - EXP#1,1

GTE EXP 1 SPR

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	993.14	549.99	69	70	7.4	973.98	586.94	69	71	7.8
1ST.STG.INLETASSY.	1573.51	864.05	65	70	12	1460.29	866.14	70	71	11.8
2ND.STG.COMPR.DIFF	2008.63	1473.81	70	70	15.9	1619.97	1007.23	68	71	13.7
2ND.STG.DIFF.ASSY	3317.43	1335.24	129	130	49.2	3247.68	1142.56	131	131	49.5
2ND.STG.DIFF.HSG.	2247.43	1483.02	75	70	17.6	2188.59	1222.81	60	71	19.8
2NDSTG.COMPR.HSG.	2175.55	1044.55	76	70	17.1	2130.89	1011.12	70	71	17
ACCESSORY CASE	420.01	179.95	130	130	6.3	436.37	224.49	130	131	6.5
BACKSHOP 180	1300.72	421.16	71	70	10	1278.96	437.96	73	71	10.5
BACKSHOP 397	666.12	577.48	128	130	9.8	636.79	597.26	131	131	9.4
BEARING HSG.	2585.21	1127.95	77	70	21.2	2741.4	1798.16	76	71	22.4
COMB. CHAMBER LNG.	709.45	196.79	66	70	5.3	737.19	217.27	73	71	5.9
COMPRESSOR INLET	1789.64	1120.51	135	130	26.6	1572.88	1168.66	129	131	23.8
[redacted]										
GTE -397	3508.18	209.5	127	132	52.7	3492.54	197.13	133	132	53.2
MATPSI 180 ONLY	717.69	159.8	67	70	5.5	723.03	144.5	71	71	5.8
MATPSI 397 ONLY	737.99	156.43	130	130	11.1	729.19	150.48	128	131	10.9
TORUS TURBINE	1009.01	354.64	69	70	7.6	1001.16	398.96	73	71	8
TURBINE BRG. HSG.	2386.49	2010.9	136	130	34	2557.69	2137.75	124	131	40
TURBINE NOZZLE 180	1545.23	1022.23	65	70	12.2	1542.56	1116.59	68	71	12.3
TURBINE NOZZLE 397	2050.52	1758.16	133	130	30.3	1839.53	1974.52	126	131	28
WHEEL&SHAFTASSY.	2105.31	1045	75	70	15.8	1930.78	765.55	74	71	15.7

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	983.6	568.5	69.0	70.5	7.6
1ST.STG.INLETASSY.	1516.9	865.1	67.5	70.5	11.9
2ND.STG.COMPR.DIFF	1814.3	1240.5	69.0	70.5	14.8
2ND.STG.DIFF.ASSY	3282.6	1238.9	130.0	130.5	49.4
2ND.STG.DIFF.HSG.	2218.0	1352.9	67.5	70.5	18.7
2NDSTG.COMPR.HSG.	2153.2	1027.8	73.0	70.5	17.1
ACCESSORY CASE	428.2	202.2	130.0	130.5	6.4
BACKSHOP 180	1289.8	429.6	72.0	70.5	10.3
BACKSHOP 397	651.5	587.4	129.5	130.5	9.6
BEARING HSG.	2663.3	1463.1	76.5	70.5	21.8
COMB. CHAMBER LNG.	723.3	207.0	69.5	70.5	5.6
COMPRESSOR INLET	1681.3	1144.6	132.0	130.5	25.2
[redacted]					
MATPSI 180 ONLY	720.4	152.2	69.0	70.5	5.7
MATPSI 397 ONLY	733.6	153.5	129.0	130.5	11.0
TORUS TURBINE	1005.1	376.8	71.0	70.5	7.8
TURBINE BRG. HSG.	2472.1	2074.3	130.0	130.5	37.0
TURBINE NOZZLE 180	1543.9	1069.4	66.5	70.5	12.3
TURBINE NOZZLE 397	1945.0	1866.3	129.5	130.5	29.2
WHEEL&SHAFTASSY.	2018.0	905.3	74.5	70.5	15.8

GTE - EXP#2,1

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1009.15	558.27	107	107	12.1	932.47	502.31	107	109	11.6
1ST.STG.INLETASSY.	1572.49	794.79	104	107	19.4	1487.97	1050.19	107	109	19.9
2ND.STG.COMPR.DIFF	1746.87	1188.04	113	107	21.8	1877.09	1242.37	104	109	23.3
2ND.STG.DIFF.ASSY	3323.46	1295.12	202	200	76.3	3277.9	1278.03	209	200	75.3
2ND.STG.DIFF.HSG.	2111.94	1322.59	102	107	26.2	1968.05	1378.98	111	109	23.9
2NDSTG.COMPR.HSG.	2299.82	1125.14	109	107	29	2086.38	1163.02	108	109	25.2
ACCESSORY CASE	427.71	200.25	204	200	9.8	419.62	219.38	198	200	9.5
BACKSHOP 180	1246.29	397.41	107	107	15.3	1326.13	410.22	106	109	16.3
BACKSHOP 397	707.52	770.55	198	200	16.2	722.39	857.95	205	200	16.9
BEARING HSG.	2612.59	1352.22	108	107	32.6	2644.67	1440.36	108	109	32.3
COMB. CHAMBER LNG.	725.04	182.02	107	107	9	710.92	190.36	108	109	8.9
COMPRESSOR INLET	1626.86	1117.91	200	200	39	1702.42	1214.28	198	200	38.4
[redacted]										

GTE EXP 1 SPB

GIE -397	3340.61	221.75	198	200	75.5	[illegible]50.4	153.73	206	200	75.1
MATPSI 180 ONLY	836.43	169.78	107	107	10.2	821.03	162.65	108	109	10.2
MATPSI 397 ONLY	851.25	170.05	201	200	19.5	839.39	169.24	200	200	19.1
TORUS TURBINE	1042.83	390.67	108	107	12.7	979.1	388.02	105	109	12.2
TURBINE BRG. HSG.	2502.21	1996.01	197	200	57.2	2405.53	1827.08	203	200	55.7
TURBINE NOZZLE 180	1787.35	1336.38	114	107	22	1828.36	1436.17	107	109	21.8
TURBINE NOZZLE 397	1923.18	1911.68	198	200	46.6	1649.21	1673.04	199	200	40.9
WHEEL&SHAFTASSY.	1881.89	696.75	109	107	23.3	1912.17	756.86	104	109	24.1

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	970.8	530.3	107.0	108.0	11.9
1ST.STG.INLETASSY.	1530.2	922.5	105.5	108.0	19.7
2ND.STG.COMPR.DIFF	1812.0	1215.2	108.5	108.0	22.6
2ND.STG.DIFF.ASSY	3300.7	1286.6	205.5	200.0	75.8
2ND.STG.DIFF.HSG.	2040.0	1350.8	106.5	108.0	25.1
2NDSTG.COMPR.HSG.	2193.1	1144.1	108.5	108.0	27.1
ACCESSORY CASE	423.7	209.8	201.0	200.0	9.7
BACKSHOP 180	1286.2	403.8	106.5	108.0	15.8
BACKSHOP 397	715.0	814.3	201.5	200.0	16.6
BEARING HSG.	2628.6	1396.3	108.0	108.0	32.5
COMB. CHAMBER LNG.	718.0	186.2	107.5	108.0	9.0
COMPRESSOR INLET	1664.6	1166.1	199.0	200.0	38.7
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	828.7	166.2	107.5	108.0	10.2
MATPSI 397 ONLY	845.3	169.6	200.5	200.0	19.3
TORUS TURBINE	1011.0	389.3	106.5	108.0	12.5
TURBINE BRG. HSG.	2453.9	1911.5	200.0	200.0	56.5
TURBINE NOZZLE 180	1807.9	1386.3	110.5	108.0	21.9
TURBINE NOZZLE 397	1786.2	1792.4	198.5	200.0	43.8
WHEEL&SHAFTASSY.	1897.0	726.8	106.5	108.0	23.7

GIE - EXP#3,1

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	976.07	523.57	137	142	15.2	1095.05	717.73	145	144	17.6
1ST.STG.INLETASSY.	1644.01	924.63	144	142	26.2	1513.3	859.56	144	144	25.1
2ND.STG.COMPR.DIFF	1841.6	1292.08	140	142	29	1765.32	1230.08	150	144	27.8
2ND.STG.DIFF.ASSY	3249.72	1190.2	268	267	99.7	3128.84	1094.75	257	266	95.3
2ND.STG.DIFF.HSG.	2042.17	1432.76	152	142	32.6	2041.3	1276.18	150	144	35
2NDSTG.COMPR.HSG.	2358.21	1223.84	144	142	37.3	2302.25	1317.79	151	144	37
ACCESSORY CASE	406.26	190.03	271	267	12.7	430.3	183.65	269	266	13
BACKSHOP 180	1297.64	440.15	140	142	20.6	1336.21	453.4	145	144	22.1
BACKSHOP 397	699.84	657.43	271	267	22.1	775.16	894.15	266	266	22.7
BEARING HSG.	2732.09	1624.96	149	142	42.3	2919.85	1898	151	144	48.7
COMB. CHAMBER LNG.	715.44	178.02	136	142	11.3	721.76	190.06	146	144	11.7
COMPRESSOR INLET	1658.43	1182.04	271	267	50.8	1649.51	1134.43	274	266	49.5
GIE -180	3188.61	617.93	120	144	53	3589.92	552.98	115	144	60.7
GIE -397	3356.86	437.44	228	264	104.1	3679.43	562.87	213	264	111.8
MATPSI 180 ONLY	3145.89	670.94	110	142	51.5	3578.56	590.29	108	144	59.5
MATPSI 397 ONLY	3138.93	684.94	201	267	96.2	3596.91	639.93	202	266	108.3
TORUS TURBINE	1058.25	373.54	140	142	16.7	1011.22	355.61	147	144	16.4
TURBINE BRG. HSG.	2280.33	1856.41	262	267	70.9	2465.49	1914.42	267	266	73.4
TURBINE NOZZLE 180	1689.72	1173.18	145	142	26.7	1710.75	1210.48	144	144	28.9
TURBINE NOZZLE 397	2035.99	2007.42	257	267	65.8	1924.79	1829.96	265	266	58
WHEEL&SHAFTASSY.	2000.14	825.53	141	142	31.9	2012.75	790.22	146	144	33.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1035.6	620.7	141.0	143.0	16.4
1ST.STG.INLETASSY.	1578.7	892.1	144.0	143.0	25.7
2ND.STG.COMPR.DIFF	1803.5	1261.1	145.0	143.0	28.4
2ND.STG.DIFF.ASSY	3189.3	1142.5	262.5	266.5	97.5
2ND.STG.DIFF.HSG.	2041.7	1354.5	151.0	143.0	33.8
2NDSTG.COMPR.HSG.	2330.2	1270.8	147.5	143.0	37.2

GTE EXP 1 SPR

ACCESSORY CASE	418.3	186.8	270.0	266.5	[illegible]
BACKSHOP 180	1316.9	446.8	142.5	143.0	21.4
BACKSHOP 397	737.5	775.8	268.5	266.5	22.4
BEARING HSG.	2826.0	1761.5	150.0	143.0	45.5
COMB. CHAMBER LNG.	718.6	184.0	141.0	143.0	11.5
COMPRESSOR INLET	1654.0	1158.2	272.5	266.5	50.2
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	3362.2	630.6	109.0	143.0	55.5
MATPSI 397 ONLY	3367.9	662.4	201.5	266.5	102.3
TORUS TURBINE	1034.7	364.6	143.5	143.0	16.6
TURBINE BRG. HSG.	2372.9	1885.4	264.5	266.5	72.2
TURBINE NOZZLE 180	1700.2	1191.8	144.5	143.0	27.8
TURBINE NOZZLE 397	1980.4	1918.7	261.0	266.5	61.9
WHEEL&SHAFTASSY.	2006.4	807.9	143.5	143.0	32.8

GTE - EXP#4,1

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1127.55	687.1	69	70	8.5	1011.41	552.1	73	71	7.9
1ST.STG.INLETASSY.	1644.91	907.33	68	70	12.5	1527.8	759	76	71	12.2
2ND.STG.COMPR.DIFF	1668.52	1368.61	71	70	12.6	1596.7	1048.52	76	71	13
2ND.STG.DIFF.ASSY	3197.88	1192.59	139	130	47.8	3221.49	1054.03	136	131	48.9
2ND.STG.DIFF.HSG.	2041.59	1422.07	70	70	16	2111.51	1334.63	65	71	17.2
2NDSTG.COMPR.HSG.	2037.82	1014.1	76	70	15.7	2447.97	1366.69	75	71	20.1
ACCESSORY CASE	457.9	210.69	133	130	6.8	448.84	223.41	132	131	6.7
BACKSHOP 180	1237.21	430.81	70	70	9.5	1299.18	444.93	74	71	10.5
BACKSHOP 397	783.39	734.47	127	130	11.4	727.53	687.12	127	131	11.3
BEARING HSG.	2972.83	1827.33	76	70	22.9	2989.33	2024.79	76	71	23.5
COMB. CHAMBER LNG.	762.23	188.12	68	70	5.8	714.26	184.58	70	71	5.7
COMPRESSOR INLET	1610.63	1048.26	128	130	24.5	1669.86	1150.86	136	131	25.1
GTE -180	2278.65	291.06	75	72	17.9	2354.78	247.41	73	72	19.2
GTE -397	2457.21	226.13	137	132	36.7	2473.71	181.11	136	132	37.3
MATPSI 180 ONLY	741.56	176.5	67	70	5.6	738.27	153.14	71	71	5.9
MATPSI 397 ONLY	750.39	140.54	129	130	11.2	733.15	153.42	131	131	11
TORUS TURBINE	1025.95	339.45	68	70	7.9	1027.98	348.2	72	71	8.3
TURBINE BRG. HSG.	2622.98	2187.47	131	130	39.8	2519.33	1971.2	137	131	40.4
TURBINE NOZZLE 180	1728.54	1496.29	72	70	13.4	2043.98	1573.17	76	71	16.1
TURBINE NOZZLE 397	1888.99	1759.11	132	130	27.5	1864.89	1545.37	126	131	29.5
WHEEL&SHAFTASSY.	1893.15	716.47	69	70	14.6	1953.35	919.13	61	71	16.4

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1069.5	619.6	71.0	70.5	8.2
1ST.STG.INLETASSY.	1586.4	833.2	72.0	70.5	12.4
2ND.STG.COMPR.DIFF	1632.6	1208.6	73.5	70.5	12.8
2ND.STG.DIFF.ASSY	3209.7	1123.3	137.5	130.5	48.4
2ND.STG.DIFF.HSG.	2076.6	1378.4	67.5	70.5	16.6
2NDSTG.COMPR.HSG.	2242.9	1190.4	75.5	70.5	17.9
ACCESSORY CASE	453.4	217.1	132.5	130.5	6.8
BACKSHOP 180	1268.2	437.9	72.0	70.5	10.0
BACKSHOP 397	755.5	710.8	127.0	130.5	11.4
BEARING HSG.	2981.1	1926.1	76.0	70.5	23.2
COMB. CHAMBER LNG.	738.2	186.4	69.0	70.5	5.8
COMPRESSOR INLET	1640.2	1099.6	132.0	130.5	24.8
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	739.9	164.8	69.0	70.5	5.8
MATPSI 397 ONLY	741.8	147.0	130.0	130.5	11.1
TORUS TURBINE	1027.0	343.8	70.0	70.5	8.1
TURBINE BRG. HSG.	2571.2	2079.3	134.0	130.5	40.1
TURBINE NOZZLE 180	1886.3	1534.7	74.0	70.5	14.8
TURBINE NOZZLE 397	1876.9	1652.2	129.0	130.5	28.5
WHEEL&SHAFTASSY.	1923.3	817.8	66.5	70.5	15.5

GTE - EXP#5,1

GTE EXP 1 SPR

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	892.65	470.76	103	107	11.2	885.76	415.22	105	109	11
1ST.STG.INLETASSY.	1597.66	1033.52	109	107	19.9	1642.67	1052.61	108	109	20.9
2ND.STG.COMPR.DIFF	1848.83	1162.96	109	107	23.4	1674.32	1192.62	108	109	21.7
2ND.STG.DIFF.ASSY	3247.75	1136.29	198	200	75	3231.48	1151.58	207	200	76.5
2ND.STG.DIFF.HSG.	2091.64	1304.19	110	107	25.7	2039.76	1367.42	113	109	25.2
2NDSTG.COMPR.HSG.	2264.03	1104.94	104	107	28.6	2431.69	1170.7	108	109	29.9
ACCESSORY CASE	416.07	207.57	204	200	9.5	443.47	203.49	198	200	10.2
BACKSHOP 180	1285.05	424.88	111	107	15.7	[illegible]3.53	449.82	106	109	15.7
BACKSHOP 397	670.02	668.76	205	200	15.4	715.51	763.8	202	200	16.1
BEARING HSG.	2870.81	1800.56	107	107	36	2679.08	1563.66	105	109	33
COMB. CHAMBER LNG.	709.55	179.86	106	107	8.7	723.05	163.94	109	109	9
COMPRESSOR INLET	1548.78	1061.5	201	200	35.7	1677.17	1232.28	195	200	37.5
GTE -180	3082.7	188.05	106	108	38.2	2875.63	189.76	107	108	35.4
GTE -397	3469.5	178.19	195	200	79.2	3491.41	133.79	206	200	80.6
MATPSI 180 ONLY	1188.39	228.86	106	107	14.6	1312.86	225.7	102	109	16.1
MATPSI 397 ONLY	1171.31	202.22	191	200	26.9	1301.43	209.41	195	200	29.7
TORUS TURBINE	1053.57	431.99	107	107	12.8	1079.86	466.33	102	109	13.4
TURBINE BRG. HSG.	2369.37	1909.23	206	200	55.5	2647.89	2069.61	194	200	63.9
TURBINE NOZZLE 180	1672.44	1272.55	104	107	22.7	1915.55	1354.1	104	109	24.1
TURBINE NOZZLE 397	1836.99	1711.8	200	200	43	2018.4	1894.72	201	200	46
WHEEL&SHAFTASSY.	2035.19	914.13	103	107	25	1957.02	857.04	105	109	24.2

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	889.2	443.0	104.0	108.0	11.1
1ST.STG.INLETASSY.	1620.2	1043.1	108.5	108.0	20.4
2ND.STG.COMPR.DIFF	1761.6	1177.8	108.5	108.0	22.6
2ND.STG.DIFF.ASSY	3239.6	1143.9	202.5	200.0	75.8
2ND.STG.DIFF.HSG.	2065.7	1335.8	111.5	108.0	25.5
2NDSTG.COMPR.HSG.	2347.9	1137.8	106.0	108.0	29.3
ACCESSORY CASE	429.8	205.5	201.0	200.0	9.9
BACKSHOP 180	1279.3	437.4	108.5	108.0	15.7
BACKSHOP 397	692.8	716.3	203.5	200.0	15.8
BEARING HSG.	2774.9	1682.1	106.0	108.0	34.5
COMB. CHAMBER LNG.	716.3	171.9	107.5	108.0	8.9
COMPRESSOR INLET	1613.0	1146.9	198.0	200.0	36.6
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	1250.6	227.3	104.0	108.0	15.4
MATPSI 397 ONLY	1236.4	205.8	193.0	200.0	28.3
TORUS TURBINE	1066.7	449.2	104.5	108.0	13.1
TURBINE BRG. HSG.	2508.6	1989.4	200.0	200.0	59.7
TURBINE NOZZLE 180	1794.0	1313.3	104.0	108.0	23.4
TURBINE NOZZLE 397	1927.7	1803.3	200.5	200.0	44.5
WHEEL&SHAFTASSY.	1996.1	885.6	104.0	108.0	24.6

GTE - EXP#6,1

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	982.6	593.8	137	142	15.4	976.09	507.4	143	144	15.6
1ST.STG.INLETASSY.	1589.26	868.7	135	142	25	1444.2	806.2	146	144	23.6
2ND.STG.COMPR.DIFF	1637.52	1160	137	142	27.2	1951.01	1319	154	144	31.4
2ND.STG.DIFF.ASSY	3309.06	1193	266	267	101.7	3435.13	1249	268	266	104
2ND.STG.DIFF.HSG.	2087.1	1312	144	142	32.7	2050.24	1242	138	144	34.9
2NDSTG.COMPR.HSG.	2373.75	1305	146	142	37.3	2333.42	1132	147	144	39.5
ACCESSORY CASE	435.48	214.2	272	267	13.6	431.49	197	265	266	13.1
BACKSHOP 180	1334.29	461.9	137	142	21	1337.32	453.6	147	144	22.2
BACKSHOP 397	746.69	719	274	267	23.5	746.81	717.9	268	266	22.4
BEARING HSG.	2741	1608	138	142	44	2790.35	1853	146	144	44.8
COMB. CHAMBER LNG.	724.7	190.5	134	142	11.4	719.21	154.5	143	144	11.7
COMPRESSOR INLET	1704.35	1122	256	267	53.5	1640.83	1130	263	266	47.8
GTE -180	4223.23	703.5	103	144	70	3999.54	680.3	108	144	67.5
GTE -397	4315.52	665.2	199	264	133	4104.12	588.7	206	264	125.2

MATPSI 180 ONLY	4130.36	696.3	106	142	67.7	3868.65	702.5	107	144	65.1
MATPSI 397 ONLY	4169.81	724.2	190	267	126.8	3895.64	694.3	196	266	117.8
TORUS TURBINE	988.57	352.5	143	142	15.7	988.24	368.9	148	144	16
TURBINE BRG. HSG.	2561.55	2011	275	267	80.4	2296.45	2040	267	266	73.1
TURBINE NOZZLE 180	1811.63	1277	139	142	28.9	1674.22	1157	148	144	27.6
TURBINE NOZZLE 397	1721.78	1762	261	267	54.7	1852.72	1741	254	266	54.1
WHEEL&SHAFTASSY.	1911.77	859.1	146	142	31.2	1895.14	831	154	144	31.2

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	979.3	550.6	140.0	143.0	15.5
1ST.STG.INLETASSY.	1516.7	837.4	140.5	143.0	24.3
2ND.STG.COMPR.DIFF	1794.3	1239.6	145.5	143.0	29.3
2ND.STG.DIFF.ASSY	3372.1	1221.2	267.0	266.5	102.9
2ND.STG.DIFF.HSG.	2068.7	1276.8	141.0	143.0	33.8
2NDSTG.COMPR.HSG.	2353.6	1218.7	146.5	143.0	38.4
ACCESSORY CASE	433.5	205.6	268.5	266.5	13.4
BACKSHOP 180	1335.8	457.7	142.0	143.0	21.6
BACKSHOP 397	746.8	718.4	271.0	266.5	23.0
BEARING HSG.	2765.7	1730.6	142.0	143.0	44.4
COMB. CHAMBER LNG.	722.0	172.5	138.5	143.0	11.6
COMPRESSOR INLET	1672.6	1125.7	259.5	266.5	50.7
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	3994.5	699.4	106.5	143.0	66.4
MATPSI 397 ONLY	4032.7	709.3	193.0	266.5	122.3
TORUS TURBINE	988.4	360.7	145.5	143.0	15.9
TURBINE BRG. HSG.	2429.0	2025.7	271.0	266.5	76.8
TURBINE NOZZLE 180	1742.9	1217.0	143.5	143.0	28.3
TURBINE NOZZLE 397	1787.3	1751.8	257.5	266.5	54.4
WHEEL&SHAFTASSY.	1903.5	845.1	150.0	143.0	31.2

GTE - EXP#7,1

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	998.55	507.67	69	70	7.5	871.44	461.04	74	71	6.8
1ST.STG.INLETASSY.	1678.77	1109.55	73	70	12.8	1635.05	907.56	68	71	12.9
2ND.STG.COMPR.DIFF	1717.38	1060.19	71	70	14	1974.12	1456.09	71	71	16.1
2ND.STG.DIFF.ASSY	3133.68	1053.89	135	130	46.4	3221.4	1078.94	135	131	49.3
2ND.STG.DIFF.HSG.	2409.39	1477.71	73	70	18.6	1887.32	1428.39	73	71	15
2NDSTG.COMPR.HSG.	2305.27	1053.6	73	70	17.8	2573.18	1214.96	70	71	20.9
ACCESSORY CASE	444.48	218.6	130	130	6.7	465.94	211.91	129	131	7
BACKSHOP 180	1299.89	452.89	68	70	10	1263.44	454.59	68	71	10.3
BACKSHOP 397	625.49	609.61	124	130	9.9	749.35	736.09	134	131	11
BEARING HSG.	3024.45	1741.74	71	70	25.7	2347.3	1532.32	69	71	19.8
COMB. CHAMBER LNG.	676.2	158.35	66	70	5.1	698.17	179.49	69	71	5.6
COMPRESSOR INLET	1817.24	1112.35	130	130	26.3	1497.93	1024.77	133	131	22.5
GTE -180	3144.2	262.78	73	72	25.2	2586.02	293.82	69	72	21
GTE -397	2944.76	184.57	137	132	44.3	3096.79	178.78	135	132	47.1
MATPSI 180 ONLY	719.40	172.72	65	70	5.9	732.36	161	71	71	5.9
MATPSI 397 ONLY	744.54	156.62	130	130	11.1	766.48	151.29	130	131	11.4
TORUS TURBINE	1050.49	422.61	65	70	8	993.83	339	72	71	8
TURBINE BRG. HSG.	2359.08	1729.56	130	130	34.5	2338.74	1748.77	133	131	34.5
TURBINE NOZZLE 180	1810.06	1409.24	77	70	14	1661.93	1200.75	68	71	13.9
TURBINE NOZZLE 397	2134.26	2284.53	134	130	31.8	1922.83	1891.77	131	131	28.4
WHEEL&SHAFTASSY.	1995.64	763.41	72	70	15.6	1993.79	757.27	73	71	15.9

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	935.0	484.4	71.5	70.5	7.2
1ST.STG.INLETASSY.	1656.9	1008.6	70.5	70.5	12.9
2ND.STG.COMPR.DIFF	1845.8	1258.1	71.0	70.5	15.1
2ND.STG.DIFF.ASSY	3177.5	1066.4	135.0	130.5	47.9
2ND.STG.DIFF.HSG.	2148.4	1453.1	73.0	70.5	16.8
2NDSTG.COMPR.HSG.	2439.2	1134.3	71.5	70.5	19.4
ACCESSORY CASE	455.2	215.3	129.5	130.5	6.9

GTE EXP 1 SPR

BACKSHOP 180	1281.7	453.7	68.0	70.5	16.2
BACKSHOP 397	687.4	672.9	129.0	130.5	10.5
BEARING HSG.	2685.9	1637.0	70.0	70.5	22.8
COMB. CHAMBER LNG.	687.2	168.9	67.5	70.5	5.4
COMPRESSOR INLET	1657.6	1068.6	131.5	130.5	24.4
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	755.9	166.9	68.0	70.5	5.9
MATPSI 397 ONLY	755.5	154.0	130.0	130.5	11.3
TORUS TURBINE	1022.2	380.8	68.5	70.5	8.0
TURBINE BRG. HSG.	2348.9	1739.2	131.5	130.5	34.5
TURBINE NOZZLE 180	1736.0	1305.0	72.5	70.5	14.0
TURBINE NOZZLE 397	2028.5	2088.2	132.5	130.5	30.1
WHEEL&SHAFTASSY.	1994.7	760.3	72.5	70.5	15.8

GTE - EXP#8,1

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	940.97	455.71	109	107	11.3	1068.93	502.04	107	109	13.3
1ST.STG.INLETASSY.	1623.23	889.54	112	107	20.2	1533.47	816.76	105	109	19.2
2ND.STG.COMPR.DIFF	1679.53	1193.7	111	107	21.4	1747.45	1112.68	106	109	21.9
2ND.STG.DIFF.ASSY	3287.53	1273.91	206	200	75.6	3256.15	1159.24	211	200	75.8
2ND.STG.DIFF.HSG.	2225.12	1384.43	103	107	28	2180.63	1385.72	105	109	27.1
2NDSTG.COMPR.HSG.	2353.1	1102.36	110	107	29	2545.38	1366.06	106	109	30.7
ACCESSORY CASE	429.87	191.82	200	200	9.8	451.87	203.6	200	200	10.3
BACKSHOP 180	1337.34	455.56	105	107	16.3	1324.95	423.62	109	109	16.3
BACKSHOP 397	733.48	690.7	208	200	16.5	722.85	693.51	206	200	16.3
BEARING HSG.	2811.18	1871.37	110	107	34.7	2571.08	1428.29	102	109	32.6
COMB. CHAMBER LNG.	722.1	170.27	107	107	8.8	729.21	189.99	109	109	9
COMPRESSOR INLET	1665.28	1172.69	199	200	37.5	1747.95	1163.2	199	200	40
GTE -180	2584.9	324.04	102	108	32.3	2802.19	402.97	91	108	35.2
GTE -397	2972.89	174.9	195	200	68	3045.1	280.58	187	200	70.6
MATPSI 180 ONLY	2303.02	427.48	91	107	28.9	2746.46	485.9	88	109	33.7
MATPSI 397 ONLY	2354.48	463.23	169	200	54.2	2741.74	518.12	169	200	63.1
TORUS TURBINE	1031.36	337.43	105	107	12.7	1020.34	400.69	109	109	12.6
TURBINE BRG. HSG.	2344.23	1968.48	195	200	54.8	2620.02	2121.54	212	200	56.4
TURBINE NOZZLE 180	1763.4	1264.83	113	107	21.4	1674.93	1288.96	110	109	20
TURBINE NOZZLE 397	2033.68	1931.8	206	200	46.1	1901.63	1767.82	197	200	43.6
WHEEL&SHAFTASSY.	2087.37	893.51	107	107	25.2	2009.82	915.47	109	109	24.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1005.0	478.9	108.0	108.0	12.3
1ST.STG.INLETASSY.	1578.4	853.2	108.5	108.0	19.7
2ND.STG.COMPR.DIFF	1713.5	1153.2	108.5	108.0	21.7
2ND.STG.DIFF.ASSY	3271.8	1216.6	208.5	200.0	75.7
2ND.STG.DIFF.HSG.	2202.9	1385.1	104.0	108.0	27.6
2NDSTG.COMPR.HSG.	2449.2	1234.2	108.0	108.0	29.9
ACCESSORY CASE	440.9	197.7	200.0	200.0	10.1
BACKSHOP 180	1331.1	439.6	107.0	108.0	16.3
BACKSHOP 397	728.2	692.1	207.0	200.0	16.4
BEARING HSG.	2691.1	1649.8	106.0	108.0	33.7
COMB. CHAMBER LNG.	725.7	180.1	108.0	108.0	8.9
COMPRESSOR INLET	1706.6	1167.9	199.0	200.0	38.8
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	2524.7	456.7	89.5	108.0	31.3
MATPSI 397 ONLY	2548.1	490.7	169.0	200.0	58.7
TORUS TURBINE	1025.9	369.1	107.0	108.0	12.7
TURBINE BRG. HSG.	2482.1	2045.0	203.5	200.0	55.6
TURBINE NOZZLE 180	1719.2	1276.9	111.5	108.0	20.7
TURBINE NOZZLE 397	1967.7	1849.8	201.5	200.0	44.9
WHEEL&SHAFTASSY.	2048.6	904.5	108.0	108.0	24.9

GTE EXP 1 SPR

GTE - EXP#9,1

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1010.96	508.05	131	142	16.2	959.76	525.85	144	144	15.8
1ST.STG.INLETASSY.	1660.96	1001.81	143	142	25.4	1559.28	847.57	148	144	26.3
2ND.STG.COMPR.DIFF	1793.6	1295.07	136	142	28.7	1857.67	1420.56	147	144	30
2ND.STG.DIFF.ASSY	3198.22	1122.29	250	267	98.5	3172.74	1132.36	264	266	96.2
2ND.STG.DIFF.HSG.	2401.87	1663.87	142	142	36.4	2136.67	1477.8	146	144	36.6
2NDSTG.COMPR.HSG.	2317.33	1011.17	142	142	37.4	2332.31	1259.59	150	144	38.3
ACCESSORY CASE	445.9	223.58	271	267	13.8	435.52	198.5	267	266	13.3
BACKSHOP 180	1260.96	442.76	139	142	19.7	1320.2	461.32	145	144	21.7
BACKSHOP 397	688.72	665.08	269	267	21.5	709.22	699.89	260	266	21.3
BEARING HSG.	2575.51	1515.45	140	142	41.9	2914.96	1748.69	135	144	48.3
COMB. CHAMBER LNG.	713.56	183.53	137	142	11.2	743.72	185.37	145	144	12
COMPRESSOR INLET	1544.74	1101.84	283	267	46	1643.89	1098.98	267	266	48.8
GTE -180	5325.26	914.02	97	144	88.4	5253.3	898.49	98	144	87.6
GTE -397	5353.5	901.68	169	264	163.1	5217.18	893.26	176	264	158.1
MATPSI 180 ONLY	5204.7	913.5	97	142	85.6	5093.44	908.48	99	144	84.6
MATPSI 397 ONLY	5197.12	895.17	169	267	157.9	5029.76	905.69	175	266	153
TORUS TURBINE	1042.76	398.89	138	142	16.2	1010.1	340.83	146	144	16.4
TURBINE BRG. HSG.	2336.19	1833.89	259	267	72.7	2585.24	2043.56	280	266	74.4
TURBINE NOZZLE 180	1814.48	1289.02	136	142	28.5	1931.32	1367.46	140	144	31.8
TURBINE NOZZLE 397	1755.26	1646.44	260	267	57	2046.2	1904.45	269	266	60.2
WHEEL&SHAFTASSY.	1982.7	850.94	140	142	32.1	2019.99	886.46	145	144	33.8

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	985.4	517.0	137.5	143.0	16.0
1ST.STG.INLETASSY.	1610.1	924.7	145.5	143.0	25.9
2ND.STG.COMPR.DIFF	1825.6	1357.8	141.5	143.0	29.4
2ND.STG.DIFF.ASSY	3185.5	1127.3	257.0	266.5	97.4
2ND.STG.DIFF.HSG.	2269.3	1570.8	144.0	143.0	36.5
2NDSTG.COMPR.HSG.	2324.8	1135.4	146.0	143.0	37.9
ACCESSORY CASE	440.7	211.0	269.0	266.5	13.6
BACKSHOP 180	1290.6	452.0	142.0	143.0	20.7
BACKSHOP 397	699.0	682.5	264.5	266.5	21.4
BEARING HSG.	2745.2	1632.1	137.5	143.0	45.1
COMB. CHAMBER LNG.	728.6	184.5	141.0	143.0	11.6
COMPRESSOR INLET	1594.3	1100.4	275.0	266.5	47.4
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	5149.1	911.0	98.0	143.0	85.1
MATPSI 397 ONLY	5113.4	900.4	172.0	266.5	155.5
TORUS TURBINE	1026.4	369.9	142.0	143.0	16.3
TURBINE BRG. HSG.	2460.7	1938.7	269.5	266.5	73.6
TURBINE NOZZLE 180	1872.9	1328.2	138.0	143.0	30.2
TURBINE NOZZLE 397	1900.7	1775.4	264.5	266.5	58.6
WHEEL&SHAFTASSY.	2001.3	868.7	142.5	143.0	33.0

GTE - EXP#1,2

GTE EXP 2 SPR

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1001.33	483	72	72	8.3	950.89	559	72	72	8
1ST.STG.INLETASSY.	1447.91	890.7	75	72	11.8	1616.04	1040	72	72	13.2
2ND.STG.COMPR.DIFF	1662.31	1268	76	72	13.8	1952.37	1290	68	72	16.3
2ND.STG.DIFF.ASSY	3232.62	1258	136	132	48	3429.81	1190	133	132	51.5
2ND.STG.DIFF.HSG.	1931.68	1395	69	72	16	1979.07	1246	67	72	16.1
2NDSTG.COMPR.HSG.	2168.37	1042	74	72	18	2372.29	1207	70	72	19.5
ACCESSORY CASE	422.36	183.8	134	132	6.3	438.45	220.4	132	132	6
BACKSHOP 180	1309.54	451.9	70	72	10.8	1325.64	434.5	72	72	[illegible]
BACKSHOP 397	662.04	596.2	136	132	9.7	866.36	844.9	134	132	12.9
BEARING HSG.	2750.25	1807	73	72	22.4	2834.88	2160	73	72	[illegible]
COMB. CHAMBER LNG.	731.38	183.8	72	72	6	698.51	171.3	71	72	[illegible]
COMPRESSOR INLET	1773.21	1280	140	132	26.4	1758.79	1115	141	132	[illegible]
GTE -180	3032.17	251.3	72	72	25	3069.82	292.5	72	72	[illegible]
GTE -397	3481.11	266.3	136	132	52.5	3712.25	282	131	132	56.1
MATPSI 180 ONLY	758.07	147.6	73	72	6.3	768.44	140.8	72	72	6.3
MATPSI 397 ONLY	774.24	149.7	134	132	11.7	773.57	168.1	135	132	11.7
TORUS TURBINE	1070.54	483.5	71	72	8.9	1038.07	335.8	72	72	[illegible]
TURBINE BRG. HSG.	2618.34	2024	132	132	41	2370.46	2138	130	132	[illegible]
TURBINE NOZZLE 180	1892.48	1471	75	72	16	2069.77	1372	76	72	[illegible]
TURBINE NOZZLE 397	1680.52	1411	120	132	26.5	1961.4	1898	129	132	29.2
WHEEL&SHAFTASSY.	2015.46	897.4	71	72	17	1963.83	796.5	70	72	16.5

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	976.1	521.0	72.0	72.0	8.2
1ST.STG.INLETASSY.	1532.0	965.4	73.5	72.0	12.5
2ND.STG.COMPR.DIFF	1807.3	1278.7	72.0	72.0	15.1
2ND.STG.DIFF.ASSY	3331.2	1238.9	134.5	132.0	49.8
2ND.STG.DIFF.HSG.	1955.4	1320.6	68.0	72.0	16.1
2NDSTG.COMPR.HSG.	2270.3	1124.6	72.0	72.0	18.8
ACCESSORY CASE	430.4	202.1	133.0	132.0	6.5
BACKSHOP 180	1317.6	443.2	71.0	72.0	10.9
BACKSHOP 397	764.2	720.6	135.0	132.0	11.3
BEARING HSG.	2792.6	1984.0	73.0	72.0	22.6
COMB. CHAMBER LNG.	714.9	177.5	71.5	72.0	5.9
COMPRESSOR INLET	1766.0	1197.4	140.5	132.0	26.1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	763.3	144.2	72.5	72.0	6.3
MATPSI 397 ONLY	773.9	158.9	134.5	132.0	11.7
TORUS TURBINE	1054.3	409.7	71.5	72.0	8.8
TURBINE BRG. HSG.	2494.4	2081.1	131.0	132.0	39.4
TURBINE NOZZLE 180	1981.1	1421.8	75.5	72.0	16.3
TURBINE NOZZLE 397	1821.0	1654.8	124.5	132.0	27.9
WHEEL&SHAFTASSY.	1989.6	847.0	70.5	72.0	16.8

GTE - EXP#2,2

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	951.55	441.3	112	108	11.8	1001.86	532.2	113	108	12.2
1ST.STG.INLETASSY.	1525.07	838	109	108	19	1559.02	888.7	110	108	18.8
2ND.STG.COMPR.DIFF	1674.27	1249	104	108	21.5	1742.76	1195	105	108	21.5
2ND.STG.DIFF.ASSY	3180.62	1209	200	198	71.9	3227.76	1210	192	198	73.6
2ND.STG.DIFF.HSG.	1726.15	1153	102	108	22.9	1986.99	1317	108	108	24.3
2NDSTG.COMPR.HSG.	2300.68	1245	109	108	29.3	2353.38	1334	100	108	28.3
ACCESSORY CASE	472.13	234.8	196	198	10.7	439.25	224	198	198	10
BACKSHOP 180	1225.61	440.2	109	108	15.1	1323.05	419.6	107	108	16.4
BACKSHOP 397	773.92	758.8	197	198	17.2	762.27	757.4	198	198	17
BEARING HSG.	2768.19	1516	104	108	34	2774.92	1544	112	108	34.3
COMB. CHAMBER LNG.	719.61	175.5	108	108	8.9	722.73	208.3	109	108	9
COMPRESSOR INLET	1541.1	984	207	198	34.9	1484.54	1064	203	198	33.2
GTE -180	2890.58	279	104	108	35.8	2925.92	333.2	110	108	36.2

GTE EXP 2 SPR

GTE -397	3262.21	281.1	200	198	[illegible]	[illegible]	266.6	195	198	75.1
MATPSI 180 ONLY	899.17	217.7	108	108	11.1	894.84	193.3	108	108	11.1
MATPSI 397 ONLY	950.74	222.7	194	198	21.4	875.44	200.6	195	198	19.8
TORUS TURBINE	1030.76	427.1	108	108	12.7	1002.94	353.3	109	108	12.4
TURBINE BRG. HSG.	2291.54	1920	196	198	53.3	2677.5	2231	194	198	59.5
TURBINE NOZZLE 180	1592.87	1184	104	108	20.6	1891.5	1426	104	108	23.7
TURBINE NOZZLE 397	2040.02	2140	203	198	44.4	1912.02	1802	198	198	45.9
WHEEL&SHAFTASSY.	2084.24	979.6	108	108	25.5	1996.81	864.3	110	108	24.9

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	976.7	486.7	112.5	108.0	12.0
1ST.STG.INLETASSY.	1542.0	863.3	109.5	108.0	18.9
2ND.STG.COMPR.DIFF	1708.5	1222.0	104.5	108.0	21.5
2ND.STG.DIFF.ASSY	3204.2	1209.3	196.0	198.0	72.8
2ND.STG.DIFF.HSG.	1856.6	1235.0	105.0	108.0	23.6
2NDSTG.COMPR.HSG.	2327.0	1289.4	104.5	108.0	28.8
ACCESSORY CASE	455.7	229.4	197.0	198.0	10.4
BACKSHOP 180	1274.3	429.9	108.0	108.0	15.8
BACKSHOP 397	768.1	758.1	197.5	198.0	17.1
BEARING HSG.	2771.6	1529.9	108.0	108.0	34.2
COMB. CHAMBER LNG.	721.2	121.9	108.5	108.0	9.0
COMPRESSOR INLET	1512.8	1024.2	205.0	198.0	34.1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	897.0	205.5	108.0	108.0	11.1
MATPSI 397 ONLY	913.1	211.6	194.5	198.0	20.6
TORUS TURBINE	1016.9	390.2	108.5	106.0	12.6
TURBINE BRG. HSG.	2484.5	2075.5	195.0	198.0	56.4
TURBINE NOZZLE 180	1742.2	1305.0	104.0	108.0	22.2
TURBINE NOZZLE 397	1976.0	1970.8	200.5	198.0	45.2
WHEEL&SHAFTASSY.	2040.5	922.0	109.0	108.0	25.2

GTE - EXP#3,2

RUN#1 RUN #2

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	971.54	543.6	138	144	16.3	995.39	501.4	142	144	16.2
1ST.STG.INLETASSY.	1593.04	922.7	142	144	26	1472.11	855.1	142	144	24.6
2ND.STG.COMPR.DIFF	1612.42	1178	141	144	25.8	1706.23	1237	147	144	27.5
2ND.STG.DIFF.ASSY	3240.01	1260	260	264	97.3	3205.01	1114	261	264	98
2ND.STG.DIFF.HSG.	1998.8	1374	136	144	34.3	1786.02	1169	143	144	29.3
2NDSTG.COMPR.HSG.	2301.74	1166	145	144	38.2	2350.36	1208	133	144	38.8
ACCESSORY CASE	473.13	238.1	265	264	14.2	466.14	220.4	267	264	14.1
BACKSHOP 180	1318.36	457.3	146	144	21.7	1305.98	445.4	141	144	21.3
BACKSHOP 397	738.9	693.1	262	264	22.3	678.59	693.1	268	264	20.6
BEARING HSG.	2705.41	1664	140	144	45.3	2597.97	1589	141	144	43.7
COMB. CHAMBER LNG.	690.49	168.3	144	144	11.4	705.17	170.4	144	144	11.6
COMPRESSOR INLET	1661.88	1227	268	264	52	1722.63	1207	270	264	50.7
GTE -180	3640.05	575.5	117	144	59.3	3497.09	545.5	118	144	56.8
GTE -397	3562.42	496.2	216	264	108.8	3482.78	463.2	223	264	106.4
MATPSI 180 ONLY	3469.4	528.6	118	144	56.5	3296.46	507.4	118	144	54
MATPSI 397 ONLY	3380.61	498.4	212	264	102.7	3263.71	519.1	211	264	99.1
TORUS TURBINE	1018.35	407	145	144	16.6	1070.4	365.5	141	144	17.6
TURBINE BRG. HSG.	2322.04	1971	261	264	71.2	2475.68	2102	257	264	76
TURBINE NOZZLE 180	1886.95	1443	143	144	31.6	1634.48	1249	137	144	27.6
TURBINE NOZZLE 397	1783.[illegible]3	1756	260	264	54.6	1906.15	1859	262	264	55.8
WHEEL&SHAFTASSY.	1947.16	716	147	144	32.3	1892.74	771.8	142	144	31.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	983.5	522.5	140.0	144.0	16.3
1ST.STG.INLETASSY.	1532.6	888.9	142.0	144.0	25.3
2ND.STG.COMPR.DIFF	1659.3	1207.6	144.0	144.0	26.7
2ND.STG.DIFF.ASSY	3222.5	1187.1	260.5	264.0	97.7
2ND.STG.DIFF.HSG.	1892.4	1271.3	139.5	144.0	31.8
2NDSTG.COMPR.HSG.	2326.1	1187.0	139.0	144.0	38.5

GTE EXP 2 SPR

ACCESSORY CASE	469.6	229.2	266.0	264.0	[illegible]
BACKSHOP 180	1312.2	451.4	143.5	144.0	21.5
BACKSHOP 397	708.7	693.1	265.0	264.0	21.5
BEARING HSG.	2651.7	1626.4	140.5	144.0	44.5
COMB. CHAMBER LNG.	697.8	169.3	144.0	144.0	11.5
COMPRESSOR INLET	1692.3	1216.6	269.0	264.0	51.4
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	3382.9	518.0	118.0	144.0	55.3
MATPSI 397 ONLY	3322.2	508.7	211.5	264.0	100.9
TORUS TURBINE	1044.4	386.3	143.0	144.0	17.1
TURBINE BRG. HSG.	2398.9	2036.3	259.0	264.0	73.6
TURBINE NOZZLE 180	1760.7	1345.9	140.0	144.0	29.6
TURBINE NOZZLE 397	1845.0	1807.7	261.0	264.0	55.2
WHEEL&SHAFTASSY.	1920.0	743.9	144.5	144.0	32.0

GTE - EXP#4,2

	RUN #1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	977.55	676.4	71	72	8.1	936.93	420.3	74	72	8
1ST.STG.INLETASSY.	1355.19	823.8	68	72	11.2	1477.24	887.5	72	72	12
2ND.STG.COMPR.DIFF	1842.6	1464	77	72	16.5	1925.35	1286	72	72	15.1
2ND.STG.DIFF.ASSY	3292.64	1084	129	132	49.8	3218.33	1204	138	132	48.1
2ND.STG.DIFF.HSG.	1955.51	1265	74	72	15	2024.02	1354	76	72	16
2NDSTG.COMPR.HSG.	2389.55	1067	67	72	19.7	1972.44	1175	75	72	15.9
ACCESSORY CASE	428.91	197.4	132	132	6.5	442.72	197.4	130	132	6.7
BACKSHOP 180	1348.77	456.5	69	72	11.2	1175.84	464.4	73	72	9.7
BACKSHOP 397	647.18	660.3	135	132	9.3	668.72	592.4	135	132	10
BEARING HSG.	2544.83	1499	79	72	20.4	2637.25	1795	72	72	21.9
COMB. CHAMBER LNG.	709.77	159.9	73	72	5.9	742.84	195.7	72	72	6.1
COMPRESSOR INLET	1683.24	1083	130	132	24.8	1647.15	1084	128	132	24.9
GTE -180	2215.25	377.2	76	72	18.2	2149.33	288.6	72	72	17.7
GTE -397	2564.08	261.7	130	132	38.8	2516.86	276.9	136	132	38
MATPSI 180 ONLY	800.42	183.2	73	72	6.6	727.58	158	72	72	6
MATPSI 397 ONLY	753.38	169.7	134	132	11.4	763.75	180.6	132	132	11.5
TORUS TURBINE	981.35	376.5	73	72	8.1	985.8	347.1	71	72	8
TURBINE BRG. HSG.	2464.46	2000	128	132	38	2614.34	1829	138	132	40
TURBINE NOZZLE 180	1522.84	1028	71	72	12.6	1760.56	1398	71	72	15
TURBINE NOZZLE 397	1829.1	1651	130	132	27.5	1850.33	1561	123	132	28.6
WHEEL&SHAFTASSY.	2086.84	754.9	71	72	17.4	2155.1	958.9	69	72	17.7

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	957.2	548.3	72.5	72.0	8.1
1ST.STG.INLETASSY.	1416.2	855.7	70.0	72.0	11.6
2ND.STG.COMPR.DIFF	1884.0	1375.0	74.5	72.0	15.8
2ND.STG.DIFF.ASSY	3255.5	1144.1	133.5	132.0	49.0
2ND.STG.DIFF.HSG.	1989.8	1309.5	75.0	72.0	15.5
2NDSTG.COMPR.HSG.	2181.0	1121.1	71.0	72.0	17.8
ACCESSORY CASE	435.8	197.4	131.0	132.0	6.6
BACKSHOP 180	1262.3	460.4	71.0	72.0	10.5
BACKSHOP 397	658.0	626.4	135.0	132.0	9.7
BEARING HSG.	2591.0	1647.0	75.5	72.0	21.2
COMB. CHAMBER LNG.	726.3	177.8	72.5	72.0	6.0
COMPRESSOR INLET	1665.2	1083.4	129.0	132.0	24.9
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	764.0	170.6	72.5	72.0	6.3
MATPSI 397 ONLY	758.6	175.2	133.0	132.0	11.5
TORUS TURBINE	983.6	361.8	72.0	72.0	8.1
TURBINE BRG. HSG.	2539.4	1914.3	133.0	132.0	39.0
TURBINE NOZZLE 180	1641.7	1213.4	71.0	72.0	13.8
TURBINE NOZZLE 397	1839.7	1606.1	126.5	132.0	28.1
WHEEL&SHAFTASSY.	2121.0	856.9	70.0	72.0	17.6

GTE - EXP#5,2

GTE EXP 2 SPR

RUN#1 | RUN #2

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	962.45	484.8	107	108	11.8	957.93	624.7	113	108	11.7
1ST.STG.INLETASSY.	1651.45	843.3	107	108	20.4	1609.39	881.1	106	108	20.2
2ND.STG.COMPR.DIFF	1894.63	1766	112	108	22	1778.68	1396	107	108	21.4
2ND.STG.DIFF.ASSY	3131.17	1217	203	198	70.5	3304.35	1228	197	198	74.4
2ND.STG.DIFF.HSG.	1974.64	1196	108	108	23.6	1965.73	1372	114	108	23.9
2NDSTG.COMPR.HSG.	2440	1272	110	108	29.9	2290.63	1048	109	108	27.7
ACCESSORY CASE	452.04	202.7	204	198	10.2	438.66	245	194	198	10
BACKSHOP 180	1327.43	424.8	107	108	16.4	1225.31	387.7	108	108	15.2
BACKSHOP 397	690.77	678.1	192	198	16	667.08	652.8	199	198	15
BEARING HSG.	2370.91	1673	101	108	30.5	2344.58	1399	110	108	29.9
COMB. CHAMBER LNG.	753.03	183.7	109	108	9.3	740.3	203.2	109	108	9.2
COMPRESSOR INLET	1716.76	1042	196	198	38.9	1673.47	1011	200	198	37.3
GTE -180	2848.2	257.4	102	108	35.3	2732.59	230.6	109	108	33.8
GTE -397	3390.86	229.3	203	198	76.7	3553.9	252.9	196	198	80.6
MATPSI 180 ONLY	1008.86	218.1	108	108	12.5	1265.8	221.3	110	108	15.6
MATPSI 397 ONLY	1007.57	206.3	196	198	22.7	1237.19	202	196	198	28
TORUS TURBINE	1030.93	339.1	108	108	7	999.07	377.4	106	108	12.4
TURBINE BRG. HSG.	2271.62	1824	190	198	53.6	2577.86	1964	188	198	60
TURBINE NOZZLE 180	1711.2	1305	107	108	21.4	1749.7	1350	106	108	22.4
TURBINE NOZZLE 397	1928.02	1799	211	198	43.7	1784.13	1670	194	198	40.1
WHEEL&SHAFTASSY.	1884.45	838.3	112	108	23.6	2000.56	985.3	109	108	25

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	960.2	554.7	110.0	108.0	11.8
1ST.STG.INLETASSY.	1630.4	862.2	106.5	108.0	20.3
2ND.STG.COMPR.DIFF	1836.7	1581.2	109.5	108.0	21.7
2ND.STG.DIFF.ASSY	3217.8	1222.6	200.0	198.0	72.5
2ND.STG.DIFF.HSG.	1970.2	1284.1	111.0	108.0	23.8
2NDSTG.COMPR.HSG.	2365.3	1159.9	109.5	108.0	28.8
ACCESSORY CASE	445.4	223.8	199.0	198.0	10.1
BACKSHOP 180	1276.4	406.2	107.5	108.0	15.8
BACKSHOP 397	678.9	665.5	195.5	198.0	15.5
BEARING HSG.	2357.7	1536.4	105.5	108.0	30.2
COMB. CHAMBER LNG.	746.7	193.5	109.0	108.0	9.3
COMPRESSOR INLET	1695.1	1026.2	198.0	198.0	38.1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	1137.3	219.7	109.0	108.0	14.1
MATPSI 397 ONLY	1122.4	204.2	196.0	198.0	25.4
TORUS TURBINE	1015.0	358.3	107.0	108.0	12.6
TURBINE BRG. HSG.	2424.7	1894.0	189.0	198.0	56.8
TURBINE NOZZLE 180	1730.5	1327.8	106.5	108.0	21.9
TURBINE NOZZLE 397	1856.1	1734.6	202.5	198.0	41.9
WHEEL&SHAFTASSY.	1942.5	911.8	110.5	108.0	24.3

GTE - EXP#6,2

RUN#1 | RUN #2

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	947.54	530.6	146	144	15.6	981.59	497.7	147	144	16.2
1ST.STG.INLETASSY.	1628.01	950.7	137	144	27	1560.24	888.5	144	144	25.4
2ND.STG.COMPR.DIFF	1644.25	1450	145	144	25.4	1759.34	1095	139	144	29.7
2ND.STG.DIFF.ASSY	3383.61	1181	268	264	101.8	3289.71	1152	264	264	100.4
2ND.STG.DIFF.HSG.	1946.56	1232	142	144	31.7	2168.64	1623	146	144	36.1
2NDSTG.COMPR.HSG.	2523.96	1390	142	144	43	2244.96	1075	142	144	37.5
ACCESSORY CASE	447.08	208.7	265	264	13.5	462.35	231.7	265	264	14
BACKSHOP 180	1234.04	428.8	141	144	20.2	1298.81	399.1	146	144	21.4
BACKSHOP 397	659.94	599.2	258	264	20.4	858.68	1015	264	264	25
BEARING HSG.	2718.63	1920	138	144	44.3	2598.79	1536	132	144	43.7
COMB. CHAMBER LNG.	730.89	166.1	145	144	12.1	719.34	165.3	143	144	11.8
COMPRESSOR INLET	1729.67	1186	257	264	52.7	1691.47	1074	261	264	51.1
GTE -180	4331.46	690.5	105	144	70.8	4222.08	724.6	101	144	68.9
GTE -397	4390.55	666.4	212	264	133.7	4194.97	686.3	208	264	129

GTE EXP 2 SPR

MATPSI 180 ONLY	4050.86	650	102	144	66.3	3923.95	690.6	99	144	64.5
MATPSI 397 ONLY	4088.01	699.5	203	264	123.3	3867.26	743.6	193	264	118.1
TORUS TURBINE	1028.69	338.5	143	144	17	1012.38	336.2	140	144	16.8
TURBINE BRG. HSG.	2348.6	1983	265	264	71.1	2555.66	2048	274	264	78.4
TURBINE NOZZLE 180	1810.62	1408	150	144	28.9	1744.54	1115	148	144	28.7
TURBINE NOZZLE 397	1731.73	1735	255	264	51.5	1909.51	1725	260	264	58.9
WHEEL&SHAFTASSY.	1923.28	721	139	144	32.3	1966.02	827.5	145	144	32.1

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	964.6	514.2	146.5	144.0	15.9
1ST.STG.INLETASSY.	1594.1	919.6	140.5	144.0	26.2
2ND.STG.COMPR.DIFF	1701.8	1272.5	142.0	144.0	27.6
2ND.STG.DIFF.ASSY	3336.7	1166.8	266.0	264.0	101.1
2ND.STG.DIFF.HSG.	2057.6	1427.5	144.0	144.0	33.9
2NDSTG.COMPR.HSG.	2384.5	1232.4	142.0	144.0	40.3
ACCESSORY CASE	454.7	220.2	265.0	264.0	13.8
BACKSHOP 180	1266.4	414.0	143.5	144.0	20.8
BACKSHOP 397	759.3	807.0	261.0	264.0	22.7
BEARING HSG.	2658.7	1727.8	135.0	144.0	44.0
COMB. CHAMBER LNG.	725.1	165.7	144.0	144.0	12.0
COMPRESSOR INLET	1710.6	1130.0	259.0	264.0	51.9
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	3987.4	670.3	100.5	144.0	65.4
MATPSI 397 ONLY	3977 6	721.5	198.0	264.0	120.7
TORUS TURBINE	1020.5	337.4	141.5	144.0	16.9
TURBINE BRG. HSG.	2452.1	2015.6	269.5	264.0	74.8
TURBINE NOZZLE 180	1777.6	1261.6	149.0	144.0	28.8
TURBINE NOZZLE 397	1820.6	1730.3	257.5	264.0	55.2
WHEEL&SHAFTASSY.	1944.7	774.2	142.0	144.0	32.2

GTE - EXP#7,2

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	896.93	513.8	71	72	7.4	884.23	444.4	73	72	7.1
1ST.STG.INLETASSY.	1598.15	979	70	72	13.1	1678.23	1348	73	72	13.3
2ND.STG.COMPR.DIFF	1842.65	1256	72	72	14.7	1729.26	1243	75	72	14.6
2ND.STG.DIFF.ASSY	3164.7	1271	131	132	48.5	3321.16	1225	131	132	49.5
2ND.STG.DIFF.HSG.	2131.9	1328	66	72	19.1	2015.52	1244	72	72	17
2NDSTG.COMPR.HSG.	2346.83	897.5	72	72	19.3	2490.98	1404	71	72	20.7
ACCESSORY CASE	426.07	226.6	133	132	6.4	436.28	185.3	134	132	6.5
BACKSHOP 180	1182.57	435.4	70	72	9.7	1280.52	443.5	76	72	10.8
BACKSHOP 397	668.19	667.7	130	132	10.1	724.01	798.1	137	132	10.7
BEARING HSG.	2758.52	1725	69	72	23.4	2898.7	1399	69	72	24.5
COMB. CHAMBER LNG.	747.43	208	72	72	6.2	711.77	163.2	71	72	5.9
COMPRESSOR INLET	1632.44	1064	141	132	24.9	1661.92	1117	127	132	25.2
GTE -180	2843.02	342.2	68	72	23.3	3020.14	259.8	69	72	24.9
GTE -397	3120.92	250.6	131.	132	47.1	3177.36	354.5	133	132	48
MATPSI 180 ONLY	835.85	198.5	71	72	6.9	785.64	188.5	72	72	6.5
MATPSI 397 ONLY	800.49	162.3	131	132	12.1	793.57	176.8	129	132	11.9
TORUS TURBINE	969.54	330	71	72	8	1058.16	355.3	72	72	8.7
TURBINE BRG. HSG.	2773.38	2278	137	132	40.3	2751.95	2154	134	132	39.7
TURBINE NOZZLE 180	1850.03	1554	67	72	14.8	1657.1	1203	71	72	13.3
TURBINE NOZZLE 397	1862.06	1899	126	132	29.2	2118.73	2133	131	132	30.6
WHEEL&SHAFTASSY.	1910.45	829.9	72	72	15.7	1988.06	862.8	71	72	16.2

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	890.6	479.1	72.0	72.0	7.3
1ST.STG.INLETASSY.	1638.2	1163.7	71.5	72.0	13.2
2ND.STG.COMPR.DIFF	1786.0	1249.3	73.5	72.0	14.7
2ND.STG.DIFF.ASSY	3242.9	1247.9	131.0	132.0	49.0
2ND.STG.DIFF.HSG.	2073.7	1285.7	69.0	72.0	18.1
2NDSTG.COMPR.HSG.	2418.9	1150.6	71.5	72.0	20.0

GTE EXP 2SPR

ACCESSORY CASE	431.2	205.9	133.5	132.0	[illegible]
BACKSHOP 180	1231.5	439.4	73.0	72.0	10.3
BACKSHOP 397	696.1	732.9	133.5	132.0	10.4
BEARING HSG.	2828.6	1562.2	69.0	72.0	24.0
COMB. CHAMBER LNG.	729.6	185.6	71.5	72.0	6.1
[redacted]	1647.2	1090.5	134.0	132.0	25.1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	810.7	193.5	71.5	72.0	6.7
MATPSI 397 ONLY	797.0	169.5	130.0	132.0	12.0
TORUS TURBINE	1013.9	342.6	71.5	72.0	8.4
TURBINE BRG. HSG.	2762.7	2215.8	135.5	132.0	40.0
TURBINE NOZZLE 180	1753.6	1378.4	69.0	72.0	14.1
TURBINE NOZZLE 397	1990.4	2016.3	128.5	132.0	29.9
WHEEL&SHAFTASSY.	1949.3	846.4	71.5	72.0	16.0

GTE - EXP#8 2

RUN#1						RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	949	544.1	109	108	11.8	911.52	442.9	104	108	11.3
1ST.STG.INLETASSY.	1485.91	893.3	109	108	18.2	1692.39	1113	110	108	21.5
2ND.STG.COMPR.DIFF	1933.54	1493	107	108	23.8	2114.65	1620	108	108	24.8
2ND.STG.DIFF.ASSY	3266.42	1141	196	198	74.2	3296.19	1282	199	198	75.5
2ND.STG.DIFF.HSG.	2166.48	1521	112	108	25.1	2076.94	1402	105	108	23.7
2NDSTG.COMPR.HSG.	2156.42	1036	107	108	28.3	2193.03	1176	101	108	27.6
ACCESSORY CASE	439.61	211.4	197	198	10	445.1	216.1	198	198	10.1
BACKSHOP 180	1217.52	355.7	111	108	15	1303.4	458.8	107	108	16.3
BACKSHOP 397	666.77	657.7	203	198	14.6	669.82	616	196	198	15.3
BEARING HSG.	2760.21	1517	110	108	34.9	2612.89	1471	106	108	32.4
COMB. CHAMBER LNG.	711.22	195.9	108	108	8.8	702.31	186.7	108	108	8.7
COMPRESSOR INLET	1554.24	1009	195	198	35.7	1641.66	1083	192	198	36.7
GTE -180	2981.16	399.2	96	108	37.3	2826.51	465.9	91	108	35.3
GTE -397	3132.01	292.4	178	198	71.3	3102.7	321.2	180	198	70.5
MATPSI 180 ONLY	2751.18	421.1	94	108	34.4	2664.17	486	92	108	32.9
MATPSI 397 ONLY	2784.23	424.2	167	198	62.8	2671.66	485.4	162	198	60.1
TORUS TURBINE	983.45	377.3	106	108	12.1	1001	372.2	109	108	12.3
TURBINE BRG. HSG.	2553.27	1777	192	198	59.5	2501.94	1886	191	198	59.5
TURBINE NOZZLE 180	1600.86	1314	104	108	19.8	1591.37	1434	101	108	19.5
TURBINE NOZZLE 397	1818.56	1656	185	198	41.3	1877.5	1809	200	198	40.8
WHEEL&SHAFTASSY.	1967.8	832.6	103	108	24.2	1895.45	927	101	108	23.8

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	930.3	493.5	106.5	108.0	11.6
1ST.STG.INLETASSY.	1589.2	1002.9	109.5	108.0	19.9
2ND.STG.COMPR.DIFF	2024.1	1556.8	107.5	108.0	24.3
2ND.STG.DIFF.ASSY	3281.3	1211.4	197.5	198.0	74.9
2ND.STG.DIFF.HSG.	2121.7	1461.6	108.5	108.0	24.4
2NDSTG.COMPR.HSG.	2174.7	1105.8	104.0	108.0	28.0
ACCESSORY CASE	442.4	213.7	197.5	198.0	10.1
BACKSHOP 180	1260.5	407.2	109.0	108.0	15.7
BACKSHOP 397	668.3	636.8	199.5	198.0	15.0
BEARING HSG.	2686.6	1494.2	108.0	108.0	33.7
COMB. CHAMBER LNG.	706.8	191.3	108.0	108.0	8.8
COMPRESSOR INLET	1598.0	1046.1	193.5	198.0	36.2
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	2707.7	453.5	93.0	108.0	33.7
MATPSI 397 ONLY	2727.9	454.8	164.5	198.0	61.5
TORUS TURBINE	992.2	374.7	107.5	108.0	12.2
TURBINE BRG. HSG.	2527.6	1831.6	191.5	198.0	59.5
TURBINE NOZZLE 180	1596.1	1374.2	102.5	108.0	19.7
TURBINE NOZZLE 397	1848.0	1732.8	192.5	198.0	41.1
WHEEL&SHAFTASSY.	1931.6	879.8	102.0	108.0	24.0

GTE EXP 2 SPR

GTE - EXP#9,2

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	925.73	531.6	146	144	15.2	965.58	513.6	143	144	15.6
1ST.STG.INLETASSY.	1505.02	903.2	144	144	24.9	1639.64	1027	145	144	26.6
2ND.STG.COMPR.DIFF	1619.44	1132	136	144	27.6	1670.93	1209	145	144	28.5
2ND.STG.DIFF.ASSY	3257.82	1151	264	264	99.1	3269.08	1152	263	264	100.3
2ND.STG.DIFF.HSG.	2295.52	1564	149	144	36.1	2118.97	1476	145	144	35
2NDSTG.COMPR.HSG.	2378.65	1455	140	144	39	2435.5	1272	145	144	40.6
ACCESSORY CASE	484.27	219.2	267	264	14.6	454.34	202.7	263	264	13.9
BACKSHOP 180	1303.46	483.9	147	144	21.6	1302.04	420.1	142	144	21.5
BACKSHOP 397	659.22	651.1	262	264	20.4	675.96	619.2	266	264	20.4
BEARING HSG.	2783.15	1660	136	144	46.4	2622.25	1844	136	144	44.3
COMB. CHAMBER LNG.	734.88	204.8	145	144	12.1	733.95	204.5	144	144	12.1
COMPRESSOR INLET	1546.7	1121	266	264	45.6	1587.89	1124	258	264	47.7
GTE -180	5814.05	991.1	94	144	94.3	5655.74	937.8	96	144	92.2
GTE -397	5610.53	988.5	165	264	171.6	5538.99	952.6	168	264	168.6
MATPSI 180 ONLY	5468.62	985.8	95	144	89.3	5293.42	952.8	96	144	87.2
MATPSI 397 ONLY	5334.16	961.6	161	264	162.6	5286.38	906.7	164	264	160
TORUS TURBINE	1043.37	381	141	144	17.3	1057.97	411.7	143	144	17.4
TURBINE BRG. HSG.	2517.06	2083	273	264	78	2432.71	2047	243	264	77.6
TURBINE NOZZLE-180	1721.98	1235	142	144	29.3	1808.08	1327	153	144	28.9
TURBINE NOZZLE 397	1816.2	1760	257	264	57	1706.67	1678	257	264	54.4
WHEEL&SHAFTASSY.	1953.4	853	146	144	32	1889.29	789.9	143	144	31.2

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	945.7	522.6	144.5	144.0	15.4
1ST.STG.INLETASSY.	1572.3	964.9	144.5	144.0	25.8
2ND.STG.COMPR.DIFF	1645.2	1170.7	140.5	144.0	28.1
2ND.STG.DIFF.ASSY	3263.5	1151.4	263.5	264.0	99.7
2ND.STG.DIFF.HSG.	2207.2	1520.3	147.0	144.0	35.6
2NDSTG.COMPR.HSG.	2407.1	1363.3	142.5	144.0	39.8
ACCESSORY CASE	469.3	210.9	265.0	264.0	14.3
BACKSHOP 180	1302.8	452.0	144.5	144.0	21.6
BACKSHOP 397	667.6	635.2	264.0	264.0	20.4
BEARING HSG.	2702.7	1752.2	136.0	144.0	45.4
COMB. CHAMBER LNG.	734.4	204.6	144.5	144.0	12.1
COMPRESSOR INLET	1567.3	1122.7	262.0	264.0	46.7
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	5381.0	969.3	95.5	144.0	88.3
MATPSI 397 ONLY	5310.3	934.1	162.5	264.0	161.3
TORUS TURBINE	1050.7	396.3	142.0	144.0	17.4
TURBINE BRG. HSG.	2474.9	2065.3	258.0	264.0	77.8
TURBINE NOZZLE 180	1765.0	1281.0	147.5	144.0	29.1
TURBINE NOZZLE 397	1761.4	1719.4	257.0	264.0	55.7
WHEEL&SHAFTASSY.	1921.3	821.4	144.5	144.0	31.6

GIE - EXP#1,3

GTE EXP 3 SPR

RUN#1						RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	941.43	581.96	68	70	7.1	915.87	505.27	71	71	7.5
1ST.STG.INLETASSY.	1593.89	925.82	63	70	12.4	1459.56	842.83	72	71	11.3
2ND.STG.COMPR.DIFF	2005.3	1369.96	70	70	15.2	1748.68	1042.57	69	71	14.2
2ND.STG.DIFF.ASSY	3321	1259.19	136	130	50.2	3181.97	1113.16	132	131	48.9
2ND.STG.DIFF.HSG.	2038.93	1465.14	72	70	16.1	2283.73	1621.89	72	71	18.9
2NDSTG.COMPR.HSG.	2278.14	1039.03	75	70	17.9	2351.13	1355.91	72	71	18.7
ACCESSORY CASE	453.42	221.21	131	130	6.8	425.93	204.44	129	131	6.4
BACKSHOP 180	1304.56	419.63	69	70	10	1252.79	418.54	71	71	10
BACKSHOP 397	747.04	773.13	128	130	11.2	658.12	779.94	134	131	9.8
BEARING HSG.	480.6	111.68	65	70	3.7	493.07	118.02	70	71	4
COMB. CHAMBER LNG.	709.17	196.61	65	70	5.4	698.28	184.57	71	71	5.6
COMPRESSOR INLET	1462.93	862.48	127	130	22.3	1689.84	1061.47	128	131	25.5
GIE -180	2594.56	297.73	73	72	20.6	2722.94	333.22	69	72	22.2
GIE -397	3608.37	243.62	132	132	54.3	3469.75	246.99	134	132	52.8
MATPSI 180 ONLY	733.13	140.64	65	70	5.6	755.93	161.33	71	71	6.1
MATPSI 397 ONLY	738.94	152.52	131	130	11.1	715.09	143.34	129	131	10.7
TORUS TURBINE	960.95	381.85	67	70	7.4	1088.05	417.77	71	71	8.9
TURBINE BRG. HSG.	2344.36	1785.27	132	130	35.9	2621.84	1917.54	137	131	39.5
TURBINE NOZZLE 180	1524.04	1040.01	68	70	11.8	1485.6	1161.95	74	71	12.1
TURBINE NOZZLE 397	1626.85	1471.48	126	130	25.7	2019.46	1890.87	130	131	30.5
WHEEL&SHAFTASSY.	1898.25	826.91	74	70	14.8	2015.42	884.95	71	71	15.9

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	928.7	543.6	69.5	70.5	7.3
1ST.STG.INLETASSY.	1526.7	884.3	67.5	70.5	11.9
2ND.STG.COMPR.DIFF	1877.0	1206.3	69.5	70.5	14.7
2ND.STG.DIFF.ASSY	3251.5	1186.2	134.0	130.5	49.6
2ND.STG.DIFF.HSG.	2161.3	1543.5	72.0	70.5	17.5
2NDSTG.COMPR.HSG.	2314.6	1197.5	73.5	70.5	18.3
ACCESSORY CASE	439.7	212.8	130.0	130.5	6.6
BACKSHOP 180	1278.7	419.1	70.0	70.5	10.0
BACKSHOP 397	702.6	776.5	131.0	130.5	10.5
BEARING HSG.	486.8	114.9	67.5	70.5	3.9
COMB. CHAMBER LNG.	703.7	190.6	68.0	70.5	5.5
COMPRESSOR INLET	1576.4	962.0	127.5	130.5	23.9
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	744.5	151.0	68.0	70.5	5.9
MATPSI 397 ONLY	727.0	147.9	130.0	130.5	10.9
TORUS TURBINE	1024.5	399.8	69.0	70.5	8.2
TURBINE BRG. HSG.	2483.1	1851.4	134.5	130.5	37.7
TURBINE NOZZLE 180	1504.8	1101.0	71.0	70.5	12.0
TURBINE NOZZLE 397	1823.2	1681.2	128.0	130.5	28.1
WHEEL&SHAFTASSY.	1956.8	855.9	72.5	70.5	15.4

GIE - EXP#2,3

RUN#1						RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	926.48	553.57	111	107	11.4	965.71	492.91	102	109	12.2
1ST.STG.INLETASSY.	1463.59	843.33	106	107	18.2	1567.58	898.25	105	109	19.9
2ND.STG.COMPR.DIFF	1966.83	1600.43	113	107	22.6	1682.35	1128.28	101	109	20.7
2ND.STG.DIFF.ASSY	3284.09	1191.82	203	200	74.8	3259.34	1278.57	201	200	75.5
2ND.STG.DIFF.HSG.	2406.69	1652.6	105	107	29.4	2063.42	1290.47	106	109	26.1
2NDSTG.COMPR.HSG.	2535.76	1517.15	114	107	30.3	2362.09	1121.14	108	109	29.6
ACCESSORY CASE	453.21	224.13	202	200	10.4	457.24	215.13	201	200	10.4
BACKSHOP 180	1315.73	444.55	110	107	16.1	1315.9	441.37	110	109	16.2
BACKSHOP 397	773.68	769.33	199	200	16.9	651.48	673.04	201	200	15.2
BEARING HSG.	477.91	112.25	108	107	5.9	478.99	99.96	108	109	6
COMB. CHAMBER LNG.	729.27	185.44	106	107	9	726.88	159.78	108	109	9
COMPRESSOR INLET	1580.13	1154.19	204	200	36.8	1654.31	1006.59	203	200	37.8
GIE -180	2580.17	229.43	114	108	31.9	2443.97	211.27	107	108	30.3
GIE -397	3278.59	252.19	204	200	75	3270.86	196.44	201	200	75.5
MATPSI 180 ONLY	808.16	176.37	105	107	9.9	789.26	169.83	106	109	9.8
MATPSI 397 ONLY	806.44	155.49	203	200	18.5	811.9	170.37	204	200	18.5
TORUS TURBINE	1013.8	401.66	110	107	12.3	1025.06	316.08	106	109	12.6
TURBINE BRG. HSG.	2244.46	1867.38	194	200	53.9	2654.5	2058.99	211	200	61.7

TURBINE NOZZLE 180	1689.34	1267.13	110	107	GTE EXP 3 SPR	[illegible]09.1	1261.46	107	109	20.1
TURBINE NOZZLE 397	1654.67	1718.71	186	200	37	1872.32	1721.05	208	200	43.2
WHEEL&SHAFTASSY.	1829.54	755.03	109	107	23.2	2005.69	843.7	109	109	24.8

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	946.1	523.2	106.5	108.0	11.8
1ST.STG.INLETASSY.	1515.6	870.8	105.5	108.0	19.1
2ND.STG.COMPR.DIFF	1824.6	1364.4	107.0	108.0	21.7
2ND.STG.DIFF.ASSY	3271.7	1235.2	202.0	200.0	75.2
2ND.STG.DIFF.HSG.	2235.1	1471.5	105.5	108.0	27.8
2NDSTG.COMPR.HSG.	2448.9	1319.1	111.0	108.0	30.0
ACCESSORY CASE	455.2	219.6	201.5	200.0	10.4
BACKSHOP 180	1315.8	443.0	110.0	108.0	16.2
BACKSHOP 397	712.6	721.2	200.0	200.0	16.1
BEARING HSG.	478.5	106.1	108.0	108.0	6.0
COMB. CHAMBER LNG.	728.1	172.6	107.0	108.0	9.0
COMPRESSOR INLET	1617.2	1080.4	203.5	200.0	37.3
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	798.7	173.1	105.5	108.0	9.9
MATPSI 397 ONLY	809.2	162.9	203.5	200.0	18.5
TORUS TURBINE	1019.4	358.9	108.0	108.0	12.5
TURBINE BRG. HSG.	2449.5	1963.2	202.5	200.0	57.8
TURBINE NOZZLE 180	1649.2	1264.3	108.5	108.0	20.2
TURBINE NOZZLE 397	1763.5	1719.9	197.0	200.0	40.1
WHEEL&SHAFTASSY.	1917.6	799.4	109.0	108.0	24.0

GTE - EXP#3,3

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	981.33	511.81	136	142	15.5	970.92	526.19	149	144	15.5
1ST.STG.INLETASSY.	1523.9	791.57	143	142	24.7	1520.43	851.67	153	144	24.5
2ND.STG.COMPR.DIFF	1712.42	1178.97	144	142	26.9	1821.05	1398.45	150	144	29.8
2ND.STG.DIFF.ASSY	3203.16	1184.37	259	267	99	3268.72	1185.87	267	266	99.5
2ND.STG.DIFF.HSG.	2115.73	1465.13	144	142	33.8	2141.13	1350.84	144	144	36.1
2NDSTG.COMPR.HSG.	2225.77	1125.48	144	142	35.5	2425.61	1260.02	152	144	40.6
ACCESSORY CASE	439.21	234.36	272	267	13.5	422.58	200.07	265	266	12.8
BACKSHOP 180	1306.72	433.72	141	142	20.6	1249.37	408.87	143	144	20.6
BACKSHOP 397	689.32	688.63	275	267	21	728.51	787.2	266	266	21.5
BEARING HSG.	499.81	111.3	136	142	8	491.29	111.91	140	144	8
COMB. CHAMBER LNG.	756.68	169.86	135	142	11.9	741.62	180.91	145	144	12
COMPRESSOR INLET	1551.39	1154.3	274	267	47.7	1711.54	1256.88	249	266	51.5
GTE -180	3106	576.84	116	144	50.6	3373.34	573.22	111	144	56.6
GTE -397	3193.95	384.31	231	264	98.7	3444.83	504.11	225	264	105.7
MATPSI 180 ONLY	3055.01	577.49	115	142	49.8	3359.54	581.3	111	144	56
MATPSI 397 ONLY	3033.41	546.73	208	267	92.9	3377.44	586.77	205	266	102.1
TORUS TURBINE	1047.02	372.2	138	142	16.5	1022.62	368.09	149	144	16.7
TURBINE BRG. HSG.	2276.33	1672.55	267	267	72.9	2355.44	1856.88	257	266	72.8
TURBINE NOZZLE 180	1622.74	1277.48	144	142	25.5	1680.51	1413.93	148	144	27.4
TURBINE NOZZLE 397	1929.67	1960.09	271	267	59	1887.69	1816.95	265	266	59.1
WHEEL&SHAFTASSY.	1774.73	733.09	146	142	28.3	1938	822.81	146	144	32.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	976.1	519.0	142.5	143.0	15.5
1ST.STG.INLETASSY.	1522.2	821.6	148.0	143.0	24.6
2ND.STG.COMPR.DIFF	1768.2	1288.7	147.0	143.0	28.4
2ND.STG.DIFF.ASSY	3235.9	1185.1	263.0	266.5	99.3
2ND.STG.DIFF.HSG.	2128.4	1408.0	144.0	143.0	35.0
2NDSTG.COMPR.HSG.	2325.7	1192.8	148.0	143.0	38.1
ACCESSORY CASE	430.9	217.2	268.5	266.5	13.2
BACKSHOP 180	1278.0	421.3	142.0	143.0	20.6
BACKSHOP 397	708.9	737.9	270.5	266.5	21.3
BEARING HSG.	495.6	111.6	138.0	143.0	8.0
COMB. CHAMBER LNG.	749.2	175.4	140.0	143.0	12.0
COMPRESSOR INLET	1631.5	1205.6	261.5	266.5	49.6
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	3207.3	579.4	113.0	143.0	52.9
MATPSI 397 ONLY	3205.4	566.8	206.5	266.5	97.5

TORUS TURBINE	1034.8	370.1	143.5	143.0	GTE EXP 3 SPR
TURBINE BRG. HSG.	2315.9	1764.7	262.0	266.5	72.9
TURBINE NOZZLE 180	1651.6	1345.7	146.0	143.0	26.5
TURBINE NOZZLE 397	1908.7	1888.5	268.0	266.5	59.1
WHEEL&SHAFTASSY.	1856.4	778.0	146.0	143.0	30.5

GTE - EXP#4,3

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	976.13	590.95	69	70	7.3	930.81	437.29	69	71	7.6
1ST.STG.INLETASSY.	1453.88	867.71	71	70	11	1622.56	896.07	71	71	13.2
2ND.STG.COMPR.DIFF	1962.01	1463.71	70	70	15.5	1591.1	1136.33	68	71	13.8
2ND.STG.DIFF.ASSY	3124.19	1067.07	133	130	47.8	3382.2	1235.66	143	131	51.5
2ND.STG.DIFF.HSG.	2474.97	1495.07	72	70	19.6	2367.88	1545.56	74	71	18.4
2NDSTG.COMPR.HSG.	2180.54	1131.31	65	70	18.2	2389.4	1169.24	71	71	20.2
ACCESSORY CASE	449.54	201.89	131	130	6.7	450.92	226.07	128	131	6.8
BACKSHOP 180	1304.46	457.35	69	70	10	1242.29	441.86	73	71	10.1
BACKSHOP 397	670.39	766.94	135	130	10.2	694.33	649.45	132	131	10.9
BEARING HSG.	469.58	104.1	66	70	3.6	495.04	113.88	70	71	4
COMB. CHAMBER LNG.	692.58	170.04	69	70	5.3	755.83	175.9	71	71	6.1
COMPRESSOR INLET	1531.08	1082.69	135	130	22.7	1690.94	1155.85	130	131	24.6
GTE -180	2113.25	225.56	[illegible]	72	16.5	2141.7	203.91	71	72	17.4
GTE -397	2418.68	194.21	[illegible]	132	36.2	2656.03	252.82	141	132	40.1
MATPSI 180 ONLY	770.41	159.51	67	70	5.9	716.2	157.78	72	71	5.7
MATPSI 397 ONLY	758.11	158.14	129	130	11.3	750.03	152.64	131	131	11.2
TORUS TURBINE	991.74	391.43	69	70	7.5	1046.52	340.75	71	71	8.4
TURBINE BRG. HSG.	2378.08	1902.75	129	130	36.7	2580.51	1940.01	124	131	40.3
TURBINE NOZZLE 180	1760.45	1279.3	71	70	14.7	2119.55	1430.42	72	71	17.1
TURBINE NOZZLE 397	2152.04	1929	127	130	31.9	1849.88	1854.1	131	131	27.1
WHEEL&SHAFTASSY.	1993.96	808.38	69	70	15.7	2235.85	998.27	71	71	18.3

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	953.5	514.1	69.0	70.5	7.5
1ST.STG.INLETASSY.	1538.2	881.9	71.0	70.5	12.1
2ND.STG.COMPR.DIFF	1776.6	1300.0	69.0	70.5	14.7
2ND.STG.DIFF.ASSY	3253.2	1151.4	138.0	130.5	49.7
2ND.STG.DIFF.HSG.	2421.4	1520.3	73.0	70.5	19.0
2NDSTG.COMPR.HSG.	2285.0	1150.3	68.0	70.5	19.2
ACCESSORY CASE	450.2	214.0	129.5	130.5	6.8
BACKSHOP 180	1273.4	449.6	71.0	70.5	10.1
BACKSHOP 397	682.4	708.2	133.5	130.5	10.6
BEARING HSG.	482.3	109.0	68.0	70.5	3.8
COMB. CHAMBER LNG.	724.2	173.0	70.0	70.5	5.7
COMPRESSOR INLET	1611.0	1119.3	132.5	130.5	23.7
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	743.3	158.6	69.5	70.5	5.8
MATPSI 397 ONLY	754.1	155.4	130.0	130.5	11.3
TORUS TURBINE	1019.1	366.1	70.0	70.5	8.0
TURBINE BRG. HSG.	2479.3	1921.4	126.5	130.5	38.5
TURBINE NOZZLE 180	1940.0	1354.9	71.5	70.5	15.9
TURBINE NOZZLE 397	2001.0	1891.6	129.0	130.5	29.5
WHEEL&SHAFTASSY.	2114.9	903.3	70.0	70.5	17.0

GTE - EXP#5,3

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	933.69	499.99	114	107	11.4	1060.55	571.07	101	109	13.2
1ST.STG.INLETASSY.	1519.18	768.62	99	107	19.3	1623.1	749.09	106	109	20.2
2ND.STG.COMPR.DIFF	1972.72	1370.42	108	107	24.1	1668.56	953.28	102	109	20.9
2ND.STG.DIFF.ASSY	3308.58	1255.22	205	200	75	3368.1	1232.55	208	200	78
2ND.STG.DIFF.HSG.	1971.41	1297.35	111	107	25	2063.34	1576.3	112	109	25.7
2NDSTG.COMPR.HSG.	2292.25	1078.64	107	107	28.4	2219.36	1189.39	108	109	27.1
ACCESSORY CASE	430.97	222.81	198	200	9.9	446.48	219.02	195	200	10.2
BACKSHOP 180	1304.04	441.99	106	107	16.1	1330.13	407.26	109	109	16.4
BACKSHOP 397	788.83	754.84	202	200	17.9	738.85	723.59	206	200	16.5
BEARING HSG.	491.28	114.42	110	107	6.1	475.02	111.01	108	109	5.9
COMB. CHAMBER LNG.	739.93	183.54	107	107	9.1	721.67	176.48	108	109	9

GTE EXP 3 SPR

COMPRESSOR INLET	1667.16	1125.09	187	200	[illegible]	1630.04	1134.98	197	200	36.4
GTE -180	2498.12	176.71	108	108	30.9	2435.42	171.7	107	108	30.2
GTE -397	3465.72	279.07	203	200	79.2	3555.54	240.48	207	200	82.2
MATPSI 180 ONLY	1156.9	173.56	106	107	14.2	922.48	179.49	108	109	11.4
MATPSI 397 ONLY	1176	187.34	194	200	26.9	985.39	167.79	208	200	22.5
TORUS TURBINE	985.92	342.58	104	107	12	1023.95	388.3	109	109	12.7
TURBINE BRG. HSG.	2404.01	2199.16	205	200	53.6	2545.94	2108.83	210	200	60
TURBINE NOZZLE 180	1809.01	1436.89	110	107	22.6	1633.58	1189.31	99	109	22.4
TURBINE NOZZLE 397	1834.87	1796.91	193	200	42.7	2119.27	2086.54	208	200	48.3
WHEEL&SHAFTASSY.	1981.55	823.2	109	107	24.7	1944.81	752.78	109	109	24.1

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	997.1	535.5	107.5	108.0	12.3
1ST.STG.INLETASSY.	1571.1	758.9	102.5	108.0	19.8
2ND.STG.COMPR.DIFF	1820.6	1161.9	105.0	108.0	22.5
2ND.STG.DIFF.ASSY	3338.3	1243.9	206.5	200.0	76.5
2ND.STG.DIFF.HSG.	2017.4	1436.8	111.5	108.0	25.4
2NDSTG.COMPR.HSG.	2255.8	1134.0	107.5	108.0	27.8
ACCESSORY CASE	438.7	220.9	196.5	200.0	10.1
BACKSHOP 180	1317.1	424.6	107.5	108.0	16.3
BACKSHOP 397	763.8	739.2	204.0	200.0	17.2
BEARING HSG.	483.2	112.7	109.0	108.0	6.0
COMB. CHAMBER LNG.	730.8	180.0	107.5	108.0	9.1
COMPRESSOR INLET	1648.6	1130.0	192.0	200.0	36.6
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	1039.7	176.5	107.0	108.0	12.8
MATPSI 397 ONLY	1080.7	177.6	201.0	200.0	24.7
TORUS TURBINE	1004.9	365.4	106.5	108.0	12.4
TURBINE BRG. HSG.	2475.0	2154.0	207.5	200.0	56.8
TURBINE NOZZLE 180	1721.3	1313.1	104.5	108.0	22.5
TURBINE NOZZLE 397	1977.1	1941.7	200.5	200.0	45.5
WHEEL&SHAFTASSY.	1963.2	788.0	109.0	108.0	24.4

GTE - EXP#6,3

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	958.58	576.92	140	142	15	1074.61	588.17	149	144	17.1
1ST.STG.INLETASSY.	1622.17	854.14	141	142	25.9	1468.08	809.41	141	144	24.5
2ND.STG.COMPR.DIFF	1755.51	1210.56	140	142	28	1908.28	1207.82	141	144	32.2
2ND.STG.DIFF.ASSY	3063.71	1096.24	260	267	93.5	3236.75	1195.21	273	266	96.8
2ND.STG.DIFF.HSG.	2003.95	[illegible]	147	142	31.6	2118.64	1376.12	148	144	34.9
2NDSTG.COMPR.HSG.	2347.77	[illegible]	142	142	38	2211.39	1051.73	147	144	36.2
ACCESSORY CASE	411.64	183.85	268	267	12.9	452.41	217.48	264	266	13.7
BACKSHOP 180	1345.03	432.51	136	142	21.1	1312.58	427.86	146	144	21.6
BACKSHOP 397	721.33	636.52	270	267	22.4	696.63	661.08	259	266	21.2
BEARING HSG.	477.52	95.3	136	142	7.6	487.08	99.88	140	144	7.9
COMB. CHAMBER LNG.	712.49	185.07	138	142	11.3	694.68	165.77	143	144	11.3
COMPRESSOR INLET	1586.13	1183.82	263	267	49.2	1552.87	1090.85	261	266	47.3
GTE -180	3820.11	643.15	110	144	63.3	4117.92	707.04	106	144	68.9
GTE -397	3899.76	620.71	206	264	120.7	4182.78	666.1	206	264	127.3
MATPSI 180 ONLY	[illegible]	654	111	142	60.9	3988.87	700.26	106	144	66.8
MATPSI 397 ONLY	3731.75	647.78	195	267	114.3	4043.07	693.1	191	266	121.2
TORUS TURBINE	1057.27	400.98	138	142	16.7	1033.05	351.95	149	144	16.7
TURBINE BRG. HSG.	2397.71	1982.42	265	267	73.9	2457.89	1944.32	249	266	76.6
TURBINE NOZZLE 180	1624.85	1083.28	140	142	25.4	1692.67	1160.83	139	144	29
TURBINE NOZZLE 397	1856.29	1653.73	272	267	58.6	1912.77	1819.46	260	266	57.1
WHEEL&SHAFTASSY.	1991.55	881.61	144	142	32.1	1994.17	749.1	150	144	33.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1016.6	582.5	144.5	143.0	16.1
1ST.STG.INLETASSY.	1545.1	831.8	141.0	143.0	25.2
2ND.STG.COMPR.DIFF	1831.9	1209.2	140.5	143.0	30.1
2ND.STG.DIFF.ASSY	3150.2	1145.7	266.5	266.5	95.2
2ND.STG.DIFF.HSG.	2061.3	1360.4	147.5	143.0	33.3
2NDSTG.COMPR.HSG.	2279.6	1121.2	144.5	143.0	37.1
ACCESSORY CASE	432.0	200.7	266.0	266.5	13.3
BACKSHOP 180	1328.8	430.2	141.0	143.0	21.4
BACKSHOP 397	709.0	648.8	264.5	266.5	21.8

BEARING HSG.	482.3	97.6	138.0	143.0	GTE EXP 3 SPR
COMB. CHAMBER LNG.	703.6	175.4	140.5	143.0	11.3
COMPRESSOR INLET	1569.5	1137.3	262.0	266.5	48.3
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	3841.1	677.1	108.5	143.0	63.9
MATPSI 397 ONLY	3887.4	670.4	193.0	266.5	117.8
TORUS TURBINE	1045.2	376.5	143.5	143.0	16.7
TURBINE BRG. HSG.	2427.8	1963.4	257.0	266.5	75.3
TURBINE NOZZLE 180	1658.8	1122.1	139.5	143.0	27.2
TURBINE NOZZLE 397	1884.5	1736.6	266.0	266.5	57.9
WHEEL&SHAFTASSY.	1992.9	815.4	147.0	143.0	32.9

GTE - EXP#7,3

RUN#1

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	925.86	471.34	69	70	7.2
1ST.STG.INLETASSY.	1772.13	786.58	67	70	13
2ND.STG.COMPR.DIFF	1484.05	894.34	67	70	11.5
2ND.STG.DIFF.ASSY	3438.38	1234.83	132	130	49.9
2ND.STG.DIFF.HSG.	2095.21	1427.08	73	70	15.9
2NDSTG.COMPR.HSG.	2334.33	1376.9	75	70	17
ACCESSORY CASE	432.96	193.34	127	130	6.5
BACKSHOP 180	1353.23	467.97	70	70	10.5
BACKSHOP 397	705.51	711.09	130	130	10.4
BEARING HSG.	483.46	104.09	66	70	3.7
COMB. CHAMBER LNG.	755.97	204.21	68	70	5.7
COMPRESSOR INLET	1767.58	1096.29	135	130	26.2
GTE -180	2393.39	208.3	71	72	18.9
GTE -397	3165.56	209.08	132	132	47.7
MATPSI 180 ONLY	754.77	153.89	67	70	5.8
MATPSI 397 ONLY	748.7	149.7	132	130	11.2
TORUS TURBINE	1070.38	348.6	67	70	8.2
TURBINE BRG. HSG.	2379.47	1876.83	135	130	36.4
TURBINE NOZZLE 180	2156.83	1334.68	68	70	17.6
TURBINE NOZZLE 397	1900.1	1652.69	118	130	28.4
WHEEL&SHAFTASSY.	1888.98	848.01	69	70	14

RUN #2

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	957.71	513.45	71	71	7.9
1ST.STG.INLETASSY.	1509.24	962.42	75	71	12.1
2ND.STG.COMPR.DIFF	1832.88	1220.64	66	71	14.9
2ND.STG.DIFF.ASSY	3431.21	1299.4	129	131	51.9
2ND.STG.DIFF.HSG.	1979.16	1345.21	72	71	15.5
2NDSTG.COMPR.HSG.	2547.73	1197.15	68	71	20.9
ACCESSORY CASE	435.51	212.96	133	131	6.5
BACKSHOP 180	1237.05	433.07	73	71	10.1
BACKSHOP 397	761.85	810.27	136	131	11
BEARING HSG.	467.01	106.51	69	71	3.7
COMB. CHAMBER LNG.	726.25	159.99	69	71	5.8
COMPRESSOR INLET	1685.28	1080.87	134	131	25.1
GTE -180	2560.76	278.85	67	72	20.8
GTE -397	3270.92	211.58	128	132	49.6
MATPSI 180 ONLY	761.24	158.12	70	71	6.1
MATPSI 397 ONLY	752.74	153.53	132	131	11.3
TORUS TURBINE	984.68	343.1	71	71	8
TURBINE BRG. HSG.	2552.65	2001.48	136	131	39.4
TURBINE NOZZLE 180	2028.28	1429.62	73	71	17.1
TURBINE NOZZLE 397	1989.69	1879.02	139	131	30.2
WHEEL&SHAFTASSY.	2189.21	916.47	70	71	18.1

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	941.8	492.4	70.0	70.5	7.6
1ST.STG.INLETASSY.	1640.7	874.5	71.0	70.5	12.6
2ND.STG.COMPR.DIFF	1658.5	1057.5	66.5	70.5	13.2
2ND.STG.DIFF.ASSY	3434.8	1267.1	130.5	130.5	50.9
2ND.STG.DIFF.HSG.	2037.2	1386.1	72.5	70.5	15.7
2NDSTG.COMPR.HSG.	2441.0	1287.0	71.5	70.5	19.0
ACCESSORY CASE	434.2	203.2	130.0	130.5	6.5
BACKSHOP 180	1295.1	450.5	71.5	70.5	10.3
BACKSHOP 397	733.7	760.7	133.0	130.5	10.7
BEARING HSG.	475.2	105.3	67.5	70.5	3.7
COMB. CHAMBER LNG.	741.1	182.1	68.5	70.5	5.8
COMPRESSOR INLET	1726.4	1088.6	134.5	130.5	25.7
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	758.0	156.0	68.5	70.5	6.0
MATPSI 397 ONLY	750.7	151.6	132.0	130.5	11.3
TORUS TURBINE	1027.5	345.9	69.0	70.5	8.1
TURBINE BRG. HSG.	2466.1	1939.2	135.5	130.5	37.9
TURBINE NOZZLE 180	2092.6	1382.2	70.5	70.5	17.4
TURBINE NOZZLE 397	1944.9	1765.9	128.5	130.5	29.3
WHEEL&SHAFTASSY.	2039.1	882.2	69.5	70.5	16.1

GTE - EXP#8,3

RUN#1

RUN #2

GTE EXP 3 SPR

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1073.85	624.81	106	107	13	991.33	556.65	108	109	12.2
1ST.STG.INLETASSY.	1564.06	848.57	114	107	19.4	1598.62	857.26	112	109	19.9
2ND.STG.COMPR.DIFF	1676.49	1158.75	109	107	21	1756.15	1161.27	106	109	21.5
2ND.STG.DIFF.ASSY	3284.02	1212.02	210	200	74.6	3324.19	1248.1	197	200	77.2
2ND.STG.DIFF.HSG.	2070.36	1321.74	103	107	25	1975.9	1392.08	110	109	24.2
2NDSTG.COMPR.HSG.	2141.18	968.86	104	107	27.4	2197.04	1026.39	99	109	27.7
ACCESSORY CASE	446.73	199.09	197	200	10.3	438.83	205.04	199	200	10
BACKSHOP 180	1255.7	484.41	110	107	15.3	1328.42	415.01	107	109	16.3
BACKSHOP 397	750.62	732.64	199	200	17.7	723.46	689.13	197	200	16.4
BEARING HSG.	473.76	104.79	105	107	5.9	466.58	114.02	110	109	5.8
COMB. CHAMBER LNG.	729.54	174.36	109	107	9	705.64	156.09	108	109	8.8
COMPRESSOR INLET	1667.82	1160.93	198	200	38.7	1656.69	1098.45	199	200	38.1
GTE -180	2634.94	404.98	93	108	32.9	2782.58	489.45	87	108	34.9
GTE -397	2971.27	230.4	190	200	68.3	3075.93	320.17	187	200	71.5
MATPSI 180 ONLY	2549.67	440.91	94	107	32	2696.98	500.33	86	109	34.2
MATPSI 397 ONLY	2559.09	413.98	165	200	58.6	2804.55	518.98	168	200	64.6
TORUS TURBINE	1077.38	363.68	108	107	13.2	1112.01	491.37	109	109	13.7
TURBINE BRG. HSG.	2435.65	1952.85	200	200	58.4	2370.78	2041.31	187	200	56.6
TURBINE NOZZLE 180	1626.36	1368.23	109	107	19.5	1680.58	1353.33	111	109	20.9
TURBINE NOZZLE 397	2179.19	2075.65	204	200	49	1829.06	1666.48	208	200	42
WHEEL&SHAFTASSY.	1925.8	785.65	110	107	23.6	1938.43	713.74	107	109	23.9

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1032.6	590.7	107.0	108.0	12.6
1ST.STG.INLETASSY.	1581.3	852.9	113.0	108.0	19.7
2ND.STG.COMPR.DIFF	1716.3	1160.0	107.5	108.0	21.3
2ND.STG.DIFF.ASSY	3304.1	1230.1	203.5	200.0	75.9
2ND.STG.DIFF.HSG.	2023.1	1356.9	106.5	108.0	24.6
2NDSTG.COMPR.HSG.	2169.1	997.6	101.5	108.0	27.6
ACCESSORY CASE	442.8	202.1	198.0	200.0	10.2
BACKSHOP 180	1292.1	449.7	108.5	108.0	15.8
BACKSHOP 397	737.0	710.9	198.0	200.0	17.1
BEARING HSG.	470.2	109.4	107.5	108.0	5.9
COMB. CHAMBER LNG.	717.6	165.2	108.5	108.0	8.9
COMPRESSOR INLET	1662.3	1129.7	198.5	200.0	38.4
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	2623.3	470.6	90.0	108.0	33.1
MATPSI 397 ONLY	2681.8	466.5	166.5	200.0	61.6
TORUS TURBINE	1094.7	427.5	108.5	108.0	13.5
TURBINE BRG. HSG.	2403.2	1997.1	193.5	200.0	57.5
TURBINE NOZZLE 180	1653.5	1360.8	110.0	108.0	20.2
TURBINE NOZZLE 397	2004.1	1871.1	206.0	200.0	45.5
WHEEL&SHAFTASSY.	1932.1	749.7	108.5	108.0	23.8

GTE - EXP#9,1

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1041.02	520.52	136	142	16.3	966.04	555.9	142	144	16
1ST.STG.INLETASSY.	1615.15	868.06	145	142	25.3	1515.74	836.03	141	144	25.3
2ND.STG.COMPR.DIFF	1839.41	1665.47	134	142	29.2	1742.51	1147.51	139	144	30.2
2ND.STG.DIFF.ASSY	3268.91	1245.92	266	267	99.6	3128.91	1065.78	256	266	96.6
2ND.STG.DIFF.HSG.	2158.49	1397.32	145	142	34.2	1869.16	1236.82	135	144	31.7
2NDSTG.COMPR.HSG.	2258.16	1190.81	139	142	36.4	2351.53	1044.99	145	144	39
ACCESSORY CASE	413.42	181.75	270	267	12.9	430.16	210.57	266	266	13
BACKSHOP 180	1219.3	384.48	139	142	19.3	1293.45	444.76	146	144	21.2
BACKSHOP 397	712.9	696.84	272	267	21.5	704.46	732.97	271	266	21.1
BEARING HSG.	474.33	113.1	134	142	7.6	490.16	115.72	140	144	8
COMB. CHAMBER LNG.	710.25	168.92	136	142	11.2	695.41	160.19	141	144	11.3
COMPRESSOR INLET	1598.21	1001.54	261	267	49.7	1603.85	1180.06	247	266	50.5
GTE -180	5200.97	1036	92	144	85.7	5371.24	960.57	89	144	89.7
GTE -397	5217.94	961.21	161	264	158.2	5412.66	985.59	165	264	162.6
MATPSI 180 ONLY	5047.27	1053	92	142	83	5212.86	1004.8	93	144	86.9
MATPSI 397 ONLY	5054.45	984.3	165	267	153.3	5251.4	969.18	163	266	157.9
TORUS TURBINE	1002.67	459.5	139	142	15.6	1001.44	331.46	149	144	16.5

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TURBINE BRG. HSG.	2353.62	2067.03	269	267	[illegible]	2434.87	1892.36	258	266	72.6
TURBINE NOZZLE 180	1872.34	1640.05	145	142	29.4	1945.92	1443.82	139	144	32.9
TURBINE NOZZLE 397	2001.68	2013.64	268	267	59.2	1680.95	1551.21	262	266	51.4
WHEEL&SHAFTASSY.	1916.85	829.28	145	142	30.3	2014.38	712.02	151	144	33.4

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1003.5	538.2	139.0	143.0	16.2
1ST.STG.INLETASSY.	1565.4	852.0	143.0	143.0	25.3
2ND.STG.COMPR.DIFF	1791.0	1406.5	136.5	143.0	29.7
2ND.STG.DIFF.ASSY	3198.9	1155.9	261.0	266.5	98.1
2ND.STG.DIFF.HSG.	2013.8	1317.1	140.0	143.0	33.0
2NDSTG.COMPR.HSG.	2304.8	1117.9	142.0	143.0	37.7
ACCESSORY CASE	421.8	196.2	268.0	266.5	13.0
BACKSHOP 180	1256.4	414.6	142.5	143.0	20.3
BACKSHOP 397	708.7	714.9	271.5	266.5	21.3
BEARING HSG.	482.2	114.4	137.0	143.0	7.8
COMB. CHAMBER LNG.	702.8	164.6	138.5	143.0	11.3
COMPRESSOR INLET	1601.0	1090.8	254.0	266.5	50.1
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	5130.1	1028.9	92.5	143.0	85.0
MATPSI 397 ONLY	5152.9	976.7	164.0	266.5	155.6
TORUS TURBINE	1002.1	395.5	144.0	143.0	16.1
TURBINE BRG. HSG.	2404.2	1979.7	263.5	266.5	73.1
TURBINE NOZZLE 180	1909.1	1541.9	142.0	143.0	31.2
TURBINE NOZZLE 397	1841.3	1782.4	265.0	266.5	55.3
WHEEL&SHAFTASSY.	1965.6	770.7	148.0	143.0	31.9

GTE - EXP#1,4

GTE EXP 4 SPR

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1200.02	600.9	68	72	9.8	931.32	524.9	73	72	7.6
1ST.STG.INLETASSY.	1640.56	995.7	71	72	13.3	1570.45	822.6	72	72	13.2
2ND.STG.COMPR.DIFF	1801.28	1387	75	72	14.8	1814.85	1079	67	72	15.1
2ND.STG.DIFF.ASSY	3215.56	1184	134	132	48.8	3294.82	1306	133	132	49.9
2ND.STG.DIFF.HSG.	1956.84	1504	77	72	14.8	2100.84	1426	68	72	17.3
2NDSTG.COMPR.HSG.	2194.13	973.5	68	72	18.2	2633.31	1659	70	72	21.3
ACCESSORY CASE	417.32	205.4	134	132	6.3	424.33	183.7	133	132	6.4
BACKSHOP 180	1209.18	405.8	73	72	10.1	1177.12	379.7	71	72	9.6
BACKSHOP 397	696.72	694.7	127	132	10.4	679.13	611	131	132	10.4
BEARING HSG.	463.1	98.87	73	72	3.8	484.2	113.1	73	72	4
COMB. CHAMBER LNG.	716.3	181.1	73	72	5.9	726.02	183	72	72	6
COMPRESSOR INLET	1653.76	1266	136	132	24.8	1631.65	998.9	123	132	25.1
GTE -180	2580.37	323	74	72	21.2	2885.31	353	73	72	23.8
GTE -397	3526.38	278.3	132	132	53.3	3598.36	309.5	128	132	54.3
MATPSI 180 ONLY	767.27	176.2	71	72	6.3	786.09	173.7	71	72	6.5
MATPSI 397 ONLY	789.21	150.9	135	132	12	781.88	160.2	132	132	11.8
TORUS TURBINE	1065.27	428.4	76	72	8.5	1040.06	365.5	70	72	8.5
TURBINE BRG. HSG.	2417.09	2031	132	132	36.2	2721.42	2134	132	132	39.9
TURBINE NOZZLE 180	1880.33	1336	72	72	14.8	1827.6	1403	68	72	15.6
TURBINE NOZZLE 397	2118.96	1858	131	132	34.6	1903.97	1716	126	132	28.4
WHEEL&SHAFTASSY.	1965.33	930.9	78	72	16	2003.67	857.2	74	72	16.3

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1065.7	562.9	70.5	72.0	8.7
1ST.STG.INLETASSY.	1605.5	909.1	71.5	72.0	13.3
2ND.STG.COMPR.DIFF	1808.1	1233.1	71.0	72.0	15.0
2ND.STG.DIFF.ASSY	3255.2	1245.0	133.5	132.0	49.4
2ND.STG.DIFF.HSG.	2028.8	1465.2	72.5	72.0	16.1
2NDSTG.COMPR.HSG.	2413.7	1316.4	69.0	72.0	19.8
ACCESSORY CASE	420.8	194.6	133.5	132.0	6.4
BACKSHOP 180	1193.2	392.8	72.0	72.0	9.9
BACKSHOP 397	687.9	652.9	129.0	132.0	10.4
BEARING HSG.	473.7	106.0	73.0	72.0	3.9
COMB. CHAMBER LNG.	721.2	182.0	72.5	72.0	6.0
COMPRESSOR INLET	1642.7	1132.7	129.5	132.0	25.0
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	776.7	174.9	71.0	72.0	6.4
MATPSI 397 ONLY	785.5	155.5	133.5	132.0	11.9
TORUS TURBINE	1052.7	397.0	73.0	72.0	8.5
TURBINE BRG. HSG.	2569.3	2082.2	132.0	132.0	38.1
TURBINE NOZZLE 180	1854.0	1369.6	70.0	72.0	15.2
TURBINE NOZZLE 397	2011.5	1787.0	128.5	132.0	31.5
WHEEL&SHAFTASSY.	1984.5	894.0	76.0	72.0	16.2

GTE - EXP#2,4

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	990.49	634.7	110	108	12.1	946.33	571.8	109	108	12
1ST.STG.INLETASSY.	1450.22	800.2	114	108	17.7	1462.67	768.2	113	108	17.9
2ND.STG.COMPR.DIFF	1974.57	1386	106	108	24.3	1828.44	1198	115	108	22.3
2ND.STG.DIFF.ASSY	3376.51	1340	199	198	76.4	3227.34	1225	202	198	73
2ND.STG.DIFF.HSG.	2324.52	1758	112	108	28.5	2307.29	1477	107	108	27.3
2NDSTG.COMPR.HSG.	2152.22	1235	113	108	27	2281.96	980.9	108	108	28.7
ACCESSORY CASE	440.56	218.8	200	198	10	448.36	195.7	199	198	10.2
BACKSHOP 180	1359.77	443.9	109	108	16.6	1215.82	442.3	107	108	15
BACKSHOP 397	814.22	798.4	202	198	17.9	714.27	727.1	190	198	16.1
BEARING HSG.	480.97	108.8	110	108	5.9	464.88	99.56	109	108	5.7
COMB. CHAMBER LNG.	743.89	204.7	108	108	9.2	716.51	185.8	107	108	8.8
COMPRESSOR INLET	1668.76	1121	202	198	36.9	1592.68	1085	195	198	36.6
GTE -180	2491.53	277.7	110	108	30.9	2507.98	282	109	108	31

GTE EXP 4 SRR

GIE -397	3463.12	309.0	200	198	78.4	[illegible]	269.5	205	198	74.8
MATPSI 180 ONLY	917.56	227	108	108	11.3	854.55	202	108	108	10.6
MATPSI 397 ONLY	928.64	208.5	196	198	21	839.09	210.7	197	198	19
TORUS TURBINE	984.05	361.6	107	108	12	1048.3	355.3	110	108	12.9
TURBINE BRG. HSG.	2474.34	1661	189	198	57.3	2516.68	1933	205	198	57.3
TURBINE NOZZLE 180	1724.63	1369	109	108	21.5	1995.93	1487	108	108	24
TURBINE NOZZLE 397	1786.47	1815	192	198	40.1	1819.49	1689	196	198	41
WHEEL&SHAFTASSY.	1891.21	705.7	105	108	23.4	1891.48	850.2	111	108	23.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	968.4	603.2	109.5	108.0	12.1
1ST.STG.INLETASSY.	1456.4	784.2	113.5	108.0	17.8
2ND.STG.COMPR.DIFF	1901.5	1292.2	110.5	108.0	23.3
2ND.STG.DIFF.ASSY	3301.9	1282.3	200.5	198.0	74.7
2ND.STG.DIFF.HSG.	2315.9	1617.9	109.5	108.0	27.9
2NDSTG.COMPR.HSG.	2217.1	1107.9	110.5	108.0	27.9
ACCESSORY CASE	444.5	207.3	199.5	198.0	10.1
BACKSHOP 180	1287.8	443.1	108.0	108.0	15.8
BACKSHOP 397	764.2	762.8	196.0	198.0	17.0
BEARING HSG.	472.9	104.2	109.5	108.0	5.8
COMB. CHAMBER LNG.	730.2	195.3	107.5	108.0	9.0
COMPRESSOR-INLET	1630.7	1103.2	198.5	198.0	36.8
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	886.1	214.5	108.0	108.0	11.0
MATPSI 397 ONLY	883.9	209.6	196.5	198.0	20.0
TORUS TURBINE	1016.2	358.5	108.5	108.0	12.5
TURBINE BRG. HSG.	2495.5	1797.3	197.0	198.0	57.3
TURBINE NOZZLE 180	1860.3	1428.2	108.5	108.0	22.8
TURBINE NOZZLE 397	1803.0	1752.1	194.0	198.0	40.6
WHEEL&SHAFTASSY.	1891.3	777.9	108.0	108.0	23.5

GIE - EXP#3,4

RUN#1 RUN #2

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	944.18	516.2	144	144	15.4	943.48	513.3	146	144	15.6
1ST.STG.INLETASSY.	1472.19	848.4	147	144	24.5	1627.74	789.4	138	144	26.9
2ND.STG.COMPR.DIFF	1656.03	1205	139	144	27.7	1657.23	1286	141	144	27.6
2ND.STG.DIFF.ASSY	3409.51	1246	269	264	102.4	3319.25	1204	263	264	101.1
2ND.STG.DIFF.HSG.	2108.21	1400	149	144	34.4	2067.52	1280	138	144	35.5
2NDSTG.COMPR.HSG.	2460.71	1270	144	144	40.8	2272.39	1203	144	144	36.2
ACCESSORY CASE	445.55	224.5	259	264	13.5	446.77	228.4	267	264	13.4
BACKSHOP 180	1311.71	439.4	142	144	21.8	1333.58	478.6	149	144	21.9
BACKSHOP 397	684.45	659.7	261	264	21	641.89	678.4	270	264	19.2
BEARING HSG.	480.43	100.7	145	144	7.9	483.77	99.65	143	144	8
COMB. CHAMBER LNG.	713.3	169.1	144	144	11.8	714.26	167.1	144	144	11.8
COMPRESSOR INLET	1702.51	1138	259	264	52.9	1634.13	1138	262	264	49.5
GIE -180	3489.86	587.6	118	144	56.9	3703.78	588.1	114	144	60.5
GIE -397	3545.89	439.4	232	264	108.6	3720.46	506.8	216	264	112.9
MATPSI 180 ONLY	3315.19	560.4	119	144	54.1	3562.83	535.7	115	144	57.8
MATPSI 397 ONLY	3269.23	548.8	209	264	99.1	3514.35	536.9	214	264	106.1
TORUS TURBINE	1021.87	355.5	143	144	16.7	971.77	343.6	144	144	16
TURBINE BRG. HSG.	2516.63	2066	266	264	74.2	2527.83	1972	258	264	77.5
TURBINE NOZZLE 180	1826.2	1355	142	144	29.8	1815.24	1259	144	144	30.4
TURBINE NOZZLE 397	1948.23	1906	264	264	56.8	1650.32	1678	271	264	51
WHEEL&SHAFTASSY.	1944.08	841	145	144	31.8	1910.31	787.4	138	144	31.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	943.8	514.8	145.0	144.0	15.5
1ST.STG.INLETASSY.	1550.0	818.9	142.5	144.0	25.7
2ND.STG.COMPR.DIFF	1656.6	1245.6	140.0	144.0	27.7
2ND.STG.DIFF.ASSY	3364.4	1225.0	266.0	264.0	101.8
2ND.STG.DIFF.HSG.	2087.9	1339.6	143.5	144.0	35.0
2NDSTG.COMPR.HSG.	2366.6	1236.4	144.0	144.0	38.5

ACCESSORY CASE	446.2	226.4	263.0	264.0	GTE EXP 4 SPR
BACKSHOP 180	1322.6	459.0	145.5	144.0	21.9
BACKSHOP 397	663.2	669.1	265.5	264.0	20.1
BEARING HSG.	482.1	100.2	144.0	144.0	8.0
COMB. CHAMBER LNG.	713.8	168.1	144.0	144.0	11.8
COMPRESSOR INLET	1668.3	1137.8	260.5	264.0	51.2
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	3439.0	548.1	117.0	144.0	56.0
MATPSI 397 ONLY	3391.8	542.8	211.5	264.0	102.6
TORUS TURBINE	996.8	349.5	143.5	144.0	16.4
TURBINE BRG. HSG.	2522.2	2018.7	262.0	264.0	75.9
TURBINE NOZZLE 180	1820.7	1307.0	143.0	144.0	30.1
TURBINE NOZZLE 397	1799.3	1792.1	267.5	264.0	53.9
WHEEL&SHAFTASSY.	1927.2	814.2	141.5	144.0	31.7

GTE - EXP#4,4

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST-DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	938.64	600.2	70	72	8	960.73	588.4	71	72	8.1
1ST.STG.INLETASSY.	1582.69	997.1	72	72	13	1577.4	920	72	72	12.8
2ND.STG.COMPR.DIFF	1867.23	1418	75	72	15.1	1855.05	1488	72	72	14.7
2ND.STG.DIFF.ASSY	3296.2	1276	131	132	50.4	3261.89	1093	135	132	49.9
2ND.STG.DIFF.HSG.	1962.87	1409	74	72	16.1	1999.95	1261	71	72	16.8
2NDSTG.COMPR.HSG.	2193.72	1236	73	72	18.4	2278.52	1074	66	72	18.8
ACCESSORY CASE	431.04	218.9	132	132	6.5	428.91	205.2	130	132	6.5
BACKSHOP 180	1270.06	430.9	74	72	10.4	1228.35	373.1	72	72	10.1
BACKSHOP 397	652.88	597.1	131	132	9.9	745.02	728.5	129	132	11.1
BEARING HSG.	489.03	119.1	71	72	4	492.49	108.2	72	72	4.1
COMB. CHAMBER LNG.	738.24	213.7	74	72	6.1	763.77	180.3	71	72	6.3
COMPRESSOR INLET	1816.76	1157	134	132	26.7	1693.97	1166	130	132	25.6
GTE -180	2036.23	318.8	73	72	16.8	2020.86	271.5	74	72	16.6
GTE -397	2606.25	317.2	132	132	39.4	2562.44	286.7	135	132	38.8
MATPSI 180 ONLY	762.75	170.5	72	72	6.3	740.52	168.9	75	72	6.2
MATPSI 397 ONLY	773.88	156.1	132	132	11.7	776.49	164.4	133	132	11.8
TORUS TURBINE	1016.55	317.6	72	72	8.4	1079.91	412.6	68	72	8.9
TURBINE BRG. HSG.	2322.72	1857	129	132	34.7	2239.41	1787	129	132	35.8
TURBINE NOZZLE 180	1570.27	1035	69	72	13.3	1803.85	1232	76	72	14.6
TURBINE NOZZLE 397	1928.57	1915	135	132	28.4	1710.67	1731	133	132	27.1
WHEEL&SHAFTASSY.	2059.91	930.1	73	72	16.8	1975.09	829.8	73	72	16.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	949.7	594.3	70.5	72.0	8.1
1ST.STG.INLETASSY.	1580.0	958.5	72.0	72.0	12.9
2ND.STG.COMPR.DIFF	1861.1	1453.2	73.5	72.0	14.9
2ND.STG.DIFF.ASSY	3279.0	1184.6	133.0	132.0	50.2
2ND.STG.DIFF.HSG.	1981.4	1334.9	72.5	72.0	16.5
2NDSTG.COMPR.HSG.	2236.1	1154.8	69.5	72.0	18.6
ACCESSORY CASE	430.0	212.1	131.0	132.0	6.5
BACKSHOP 180	1249.2	402.0	73.0	72.0	10.3
BACKSHOP 397	699.0	662.8	130.0	132.0	10.5
BEARING HSG.	490.8	113.6	71.5	72.0	4.1
COMB. CHAMBER LNG.	751.0	197.0	72.5	72.0	6.2
COMPRESSOR INLET	1755.4	1161.9	132.0	132.0	26.2
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	751.6	169.7	73.5	72.0	6.3
MATPSI 397 ONLY	775.2	160.3	132.5	132.0	11.8
TORUS TURBINE	1048.2	365.1	70.0	72.0	8.7
TURBINE BRG. HSG.	2281.1	1822.1	129.0	132.0	35.3
TURBINE NOZZLE 180	1687.1	1133.6	72.5	72.0	14.0
TURBINE NOZZLE 397	1819.6	1823.0	134.0	132.0	27.8
WHEEL&SHAFTASSY.	2017.5	880.0	73.0	72.0	16.7

GTE - EXP#5,4

GTE EXP 4 SPR

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1017.51	617.5	113	108	12.4	926.14	494	112	108	11.5
1ST.STG.INLETASSY.	1515.08	704.4	106	108	19.2	1418.01	880.3	104	108	17.2
2ND.STG.COMPR.DIFF	1906.79	1220	113	108	23.8	1701.67	1125	104	108	21.5
2ND.STG.DIFF.ASSY	3295.78	1261	200	198	74.6	3404.52	1289	195	198	77.7
2ND.STG.DIFF.HSG.	2086.46	1191	109	108	26.8	1868.93	1274	117	108	22.1
2NDSTG.COMPR.HSG.	2429.72	1213	107	108	29.9	2377.22	1483	113	108	28.9
ACCESSORY CASE	438.78	211.2	199	198	9.9	449.59	200.9	195	198	10.2
BACKSHOP 180	1218.42	467.3	108	108	15.2	1264	462	113	108	15.7
BACKSHOP 397	620.33	635.2	198	198	14.2	760.99	715.7	195	198	17.7
BEARING HSG.	472.03	101.5	106	108	5.8	476.36	116.4	105	108	5.9
COMB. CHAMBER LNG.	719.37	196.4	109	108	8.9	719.82	178.8	109	108	8.9
COMPRESSOR INLET	1535.64	1140	203	198	34.4	1716.19	1155	199	198	38.9
GTE -180	2699.71	243.8	108	108	33.4	2632.11	279	114	108	32.4
GTE -397	3572.35	233.5	202	198	80.9	3700.73	250	192	198	83.8
MATPSI 180 ONLY	1019.26	220.7	109	108	12.6	1053.26	210.1	108	108	13
MATPSI 397 ONLY	1014.37	231.2	202	198	23	1038.62	222.2	193	198	23.6
TORUS TURBINE	1045.99	413	109	108	12.9	1056.87	393.9	107	108	13.1
TURBINE BRG. HSG.	2675.73	2174	207	198	61.8	2623.65	2016	197	198	59.8
TURBINE NOZZLE 180	1524.31	1183	106	108	19.1	1794.91	1412	110	108	22
TURBINE NOZZLE 397	1861.53	1773	207	198	43.8	1809.96	1772	205	198	39.3
WHEEL&SHAFTASSY.	2027.54	928.1	106	108	24.7	1869.94	798.9	110	108	22.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	971.8	555.8	112.5	108.0	12.0
1ST.STG.INLETASSY.	1466.5	792.3	105.0	108.0	18.2
2ND.STG.COMPR.DIFF	1804.2	1172.6	108.5	108.0	22.7
2ND.STG.DIFF.ASSY	3350.2	1275.1	197.5	198.0	76.2
2ND.STG.DIFF.HSG.	1977.7	1232.5	113.0	108.0	24.5
2NDSTG.COMPR.HSG.	2403.5	1347.9	110.0	108.0	29.4
ACCESSORY CASE	444.2	206.1	197.0	198.0	10.1
BACKSHOP 180	1241.2	464.7	110.5	108.0	15.5
BACKSHOP 397	690.7	675.5	196.5	198.0	16.0
BEARING HSG.	474.2	108.9	105.5	108.0	5.9
COMB. CHAMBER LNG.	719.6	187.6	109.0	108.0	8.9
COMPRESSOR INLET	1625.9	1147.2	201.0	198.0	36.7
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	1036.3	215.4	108.5	108.0	12.8
MATPSI 397 ONLY	1026.5	226.7	197.5	198.0	23.3
TORUS TURBINE	1051.4	403.5	108.0	106.0	13.0
TURBINE BRG. HSG.	2649.7	2095.4	202.0	198.0	60.8
TURBINE NOZZLE 180	1659.6	1297.6	108.0	108.0	20.6
TURBINE NOZZLE 397	1835.7	1772.5	206.0	198.0	41.6
WHEEL&SHAFTASSY.	1948.7	863.5	108.0	108.0	23.7

GTE - EXP#6,4

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	994.7	466.5	145	144	16.7	1010.63	557.7	143	144	16.4
1ST.STG.INLETASSY.	1518.72	861.5	142	144	25	1618.58	1017	146	144	25.9
2ND.STG.COMPR.DIFF	1890.95	1306	145	144	31.8	1654.04	1191	139	144	28.3
2ND.STG.DIFF.ASSY	3343.98	1174	275	264	99.8	3203.19	1126	275	264	95.9
2ND.STG.DIFF.HSG.	2072.52	1364	141	144	34.1	1981.71	1270	139	144	32.4
2NDSTG.COMPR.HSG.	2142.14	1135	148	144	35.2	2298.25	1189	146	144	38.1
ACCESSORY CASE	453.76	193.4	261	264	13.7	460.59	205.4	264	264	13.9
BACKSHOP 180	1266.03	430.6	145	144	21	1275.01	400.6	147	144	21.1
BACKSHOP 397	773.11	742.6	269	264	23	770.27	710.2	262	264	24
BEARING HSG.	497.67	114.2	142	144	8.2	484.26	105.6	144	144	8
COMB. CHAMBER LNG.	704.9	206.7	144	144	11.6	722.91	177.1	143	144	11.9
COMPRESSOR INLET	1662.55	1060	263	264	49.9	1679.09	1269	274	264	49.6
GTE -180	4351.02	723.2	107	144	71.2	4071.15	737	105	144	67.5
GTE -397	4345.37	706.1	198	264	132.3	4121.77	696.7	203	264	125.6

MATPSI 180 ONLY	4199.09	657.7	103	144	[illegible]	[illegible]	672	99	144	64.5
MATPSI 397 ONLY	4145.11	709.7	195	264	125.9	3908.78	688.6	202	264	119
TORUS TURBINE	1006.56	333	143	144	16.7	1020.65	377	146	144	16.8
TURBINE BRG. HSG.	2650.19	2086	255	264	81.9	2631.91	2216	268	264	80.7
TURBINE NOZZLE 180	1735.84	1101	149	144	29.4	1621.92	1334	146	144	26
TURBINE NOZZLE 397	1885.34	1695	259	264	60.1	1800.44	1643	259	264	53.6
WHEEL&SHAFTASSY.	1925.51	801.9	141	144	32.1	1877.06	801.6	142	144	31.2

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1002.7	512.1	144.0	144.0	16.6
1ST.STG.INLETASSY.	1568.7	939.0	144.0	144.0	25.5
2ND.STG.COMPR.DIFF	1772.5	1248.5	142.0	144.0	30.1
2ND.STG.DIFF.ASSY	3273.6	1150.3	275.0	264.0	97.9
2ND.STG.DIFF.HSG.	2027.1	1316.8	140.0	144.0	33.3
2NDSTG.COMPR.HSG.	2220.2	1162.1	147.0	144.0	36.7
ACCESSORY CASE	457.2	199.4	262.5	264.0	13.8
BACKSHOP 180	1270.5	415.6	146.0	144.0	21.1
BACKSHOP 397	771.7	726.4	265.5	264.0	23.5
BEARING HSG.	491.0	109.9	143.0	144.0	8.1
COMB. CHAMBER LNG.	713.9	191.9	143.5	144.0	11.8
COMPRESSOR INLET	1670.8	1164.3	268.5	264.0	49.8
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	4065.8	664.8	101.0	144.0	66.4
MATPSI 397 ONLY	4026.9	699.2	198.5	264.0	122.5
TORUS TURBINE	1013.6	355.0	144.5	144.0	16.8
TURBINE BRG. HSG.	2641.1	2150.6	261.5	264.0	81.3
TURBINE NOZZLE 180	1678.9	1217.2	147.5	144.0	27.7
TURBINE NOZZLE 397	1842.9	1669.2	259.0	264.0	56.9
WHEEL&SHAFTASSY.	1901.3	801.7	141.5	144.0	31.7

GTE - EXP#7,4

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1046.05	584	73	72	8.8	1075.47	556.5	73	72	9
1ST.STG.INLETASSY.	1565.95	1023	71	72	12.7	1551.87	850.5	73	72	12.9
2ND.STG.COMPR.DIFF	1602.98	1255	71	72	13	1689.64	978.2	71	72	13.2
2ND.STG.DIFF.ASSY	3344.56	1179	137	132	49.7	3335.3	1304	132	132	50.4
2ND.STG.DIFF.HSG.	2167.98	1313	72	72	17.4	2203.34	1333	77	72	17.7
2NDSTG.COMPR.HSG.	2016.59	979.6	74	72	16.6	2197.35	1286	75	72	17.9
ACCESSORY CASE	429.63	204.4	133	132	6.5	421.46	186.9	132	132	6.4
BACKSHOP 180	1242.74	408	73	72	10.2	1236.72	429.1	73	72	10.3
BACKSHOP 397	772.19	815	131	132	11.7	734.18	689.7	138	132	10.7
BEARING HSG.	479.36	110.7	75	72	3.9	505.09	97.4	72	72	4.2
COMB. CHAMBER LNG.	755.39	213.8	73	72	6.2	742.77	175.8	71	72	6.1
COMPRESSOR INLET	1671.39	1112	130	132	25.4	1569.17	1071	134	132	23.8
GTE -180	2278.58	256.5	73	72	18.8	2339.11	294.8	76	72	19.3
GTE -397	3212.8	312.3	139	132	48.4	3240.97	287.7	131	132	49
MATPSI 180 ONLY	791.81	171.7	72	72	6.5	780.67	194.2	72	72	6.4
MATPSI 397 ONLY	795.37	198.1	135	132	12	816.21	188.7	130	132	12.3
TORUS TURBINE	1048.42	412.7	72	72	8.6	1052.3	401.6	70	72	8.8
TURBINE BRG. HSG.	2814.93	2066	136	132	41.5	2393.37	1776	136	132	37.1
TURBINE NOZZLE 180	1967.48	1430	66	72	16.1	1740.33	1394	72	72	14.9
TURBINE NOZZLE 397	1855.98	1915	131	132	28.5	1825.27	1693	128	132	28.8
WHEEL&SHAFTASSY.	1987.35	838.7	70	72	16.1	2105.82	884.7	77	72	17.7

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1060.8	570.2	73.0	72.0	8.9
1ST.STG.INLETASSY.	1558.9	936.7	72.0	72.0	12.8
2ND.STG.COMPR.DIFF	1646.3	1116.7	71.0	72.0	13.1
2ND.STG.DIFF.ASSY	3339.9	1241.6	134.5	132.0	50.1
2ND.STG.DIFF.HSG.	2185.7	1322.9	74.5	72.0	17.6
2NDSTG.COMPR.HSG.	2107.0	1132.7	74.5	72.0	17.3

GTE EXP 4 SPR

ACCESSORY CASE	425.5	195.7	132.5	132.0	[illegible]
BACKSHOP 180	1239.7	418.6	73.0	72.0	10.3
BACKSHOP 397	753.2	752.4	134.5	132.0	11.2
BEARING HSG.	492.2	104.1	73.5	72.0	4.1
COMB. CHAMBER LNG.	749.1	194.8	72.0	72.0	6.2
COMPRESSOR INLET	1620.3	1091.7	132.0	132.0	24.6
[redacted]					
MATPSI 180 ONLY	786.2	182.9	72.0	72.0	6.5
MATPSI 397 ONLY	805.8	193.4	132.5	132.0	12.2
TORUS TURBINE	1050.4	407.1	71.0	72.0	8.7
TURBINE BRG. HSG.	2604.2	1921.1	136.0	132.0	39.3
TURBINE NOZZLE 180	1853.9	1412.2	69.0	72.0	15.5
TURBINE NOZZLE 397	1840.6	1804.1	129.5	132.0	28.7
WHEEL&SHAFTASSY.	2046.6	861.7	73.5	72.0	16.9

GTE - EXP#8,4

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	962.11	546	109	108	12.1	886.01	413.7	108	108	11
1ST.STG.INLETASSY.	1572.1	853.6	106	108	19.5	1401.18	820.8	106	108	17.8
2ND.STG.COMPR.DIFF	1819.94	1385	111	108	22	1664.69	1240	109	108	20.4
2ND.STG.DIFF.ASSY	3321.73	1105	200	198	74.7	3305.01	1183	196	198	74.7
2ND.STG.DIFF.HSG.	1700.08	1340	104	108	22.3	2204.51	1657	109	108	26
2NDSTG.COMPR.HSG.	2334.75	1315	106	108	29.5	2370.27	1030	106	108	29.3
ACCESSORY CASE	429.25	198.9	196	198	9.8	456.69	205.1	201	198	10.3
BACKSHOP 180	1299.81	455.8	109	108	16.1	1216.32	446.2	108	108	15.1
BACKSHOP 397	712.5	696.3	200	198	16.6	768.69	739.2	198	198	18.1
BEARING HSG.	484.81	99.81	104	108	6	496.49	108	108	108	6.1
COMB. CHAMBER LNG.	713.16	187.7	108	108	8.8	729.3	174	107	108	9
COMPRESSOR INLET	1586.78	1147	198	198	36.1	1827.45	1189	188	198	40.9
GTE -180	2713.82	365.7	92	108	34	2818.88	463	91	108	35.2
GTE -397	2998.73	309.8	192	198	68	3071.75	346	182	198	69.9
MATPSI 180 ONLY	2450.65	451.3	91	108	30.8	2651.35	451.8	88	108	33.1
MATPSI 397 ONLY	2478.55	438.6	167	198	56	2721.25	506.3	168	198	61
TORUS TURBINE	998.27	391.9	108	108	12.3	1062.1	350.3	108	108	13.2
TURBINE BRG. HSG.	2568.99	2081	186	198	58.7	2542.33	1975	193	198	58.3
TURBINE NOZZLE 180	1900.34	1634	114	108	23.1	1799.69	1305	111	108	21.2
TURBINE NOZZLE 397	1841.91	1927	197	198	42.3	2030.96	1899	204	198	46.4
WHEEL&SHAFTASSY.	1884.39	815.4	110	108	23.2	1887.78	799.7	113	108	23.6

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	924.1	479.8	108.5	108.0	11.6
1ST.STG.INLETASSY.	1486.6	837.2	106.0	108.0	18.7
2ND.STG.COMPR.DIFF	1742.3	1312.3	110.0	108.0	21.2
2ND.STG.DIFF.ASSY	3313.4	1143.8	199.0	198.0	74.7
2ND.STG.DIFF.HSG.	1952.3	1498.6	106.5	108.0	24.2
2NDSTG.COMPR.HSG.	2352.5	1172.7	106.0	108.0	29.4
ACCESSORY CASE	443.0	202.0	198.5	198.0	10.1
BACKSHOP 180	1258.1	451.0	108.5	106.0	15.6
BACKSHOP 397	740.6	717.7	199.0	198.0	17.4
BEARING HSG.	490.7	103.9	106.0	108.0	6.1
COMB. CHAMBER LNG.	721.2	180.8	107.5	108.0	8.9
COMPRESSOR INLET	1707.1	1168.0	193.0	198.0	38.5
[redacted]					
MATPSI 180 ONLY	2551.0	451.6	89.5	108.0	32.0
MATPSI 397 ONLY	2599.9	472.4	167.5	198.0	58.5
TORUS TURBINE	1030.2	371.1	108.0	108.0	12.8
TURBINE BRG. HSG.	2555.7	2028.1	189.5	198.0	58.5
TURBINE NOZZLE 180	1850.0	1469.4	112.5	108.0	22.2
TURBINE NOZZLE 397	1936.4	1912.9	200.5	198.0	44.4
WHEEL&SHAFTASSY.	1886.1	807.5	111.5	108.0	23.4

GTE EXP 4 SPR

GTE - EXP#9,4

RUN#1						RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	995.08	605.9	144	144	16.6	1079.57	589.6	146	144	17.4
1ST.STG.INLETASSY.	1559.96	865.7	147	144	25.5	1589.38	926.4	147	144	26
2ND.STG.COMPR.DIFF	1603.81	1308	143	144	26.3	1715.15	1267	140	144	27.9
2ND.STG.DIFF.ASSY	3248.37	1158	255	264	97.2	3367.46	1118	270	264	101.4
2ND.STG.DIFF.HSG.	1991.08	1421	142	144	33.9	2046.1	1467	137	144	33.6
2NDSTG.COMPR.HSG.	2206.75	1176	152	144	36.1	2461.56	1197	141	144	40
ACCESSORY CASE	444.72	207.3	265	264	13.5	452.85	212.3	259	264	13.8
BACKSHOP 180	1269.84	450	145	144	20.8	1303.32	442.9	144	144	21.5
BACKSHOP 397	699.28	683.2	260	264	21.9	648.48	677.3	264	264	19.4
BEARING HSG.	499.78	107.4	148	144	8.3	484.7	109.4	143	144	8
COMB. CHAMBER LNG.	717.45	164.2	142	144	11.8	739.27	181.4	143	144	12.2
COMPRESSOR INLET	1648.64	1157	263	264	48.9	1603.69	1016	258	264	49
GTE -180	5630.4	981.4	96	144	91.9	5268.99	861.6	96	144	87.9
GTE -397	5524.66	956.8	165	264	168.1	5325.01	899.2	174	264	161.6
MATPSI 180 ONLY	5275.54	977.6	96	144	87	4922.74	828.7	95	144	82.9
MATPSI 397 ONLY	5292.23	956.4	170	264	159.4	5077.45	866.7	171	264	152.8
TORUS TURBINE	1008.05	355.5	144	144	16.6	1046.19	423.4	143	144	17.3
TURBINE BRG. HSG.	2502.56	2242	252	264	77.5	2626.13	2071	259	264	78.7
TURBINE NOZZLE 180	1613.59	1219	145	144	27.6	1859.78	1388	139	144	30.5
TURBINE NOZZLE 397	1838.08	1805	250	264	60.7	1752.12	1720	262	264	57.1
WHEEL&SHAFTASSY.	1959.67	794.6	143	144	33.1	2026.55	819	147	144	33.5

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1037.3	597.7	145.0	144.0	17.0
1ST.STG.INLETASSY.	1574.7	896.0	147.0	144.0	25.8
2ND.STG.COMPR.DIFF	1659.5	1297.6	141.5	144.0	27.1
2ND.STG.DIFF.ASSY	3307.9	1137.7	262.5	264.0	99.3
2ND.STG.DIFF.HSG.	2018.6	1444.1	139.5	144.0	33.8
2NDSTG.COMPR.HSG.	2334.2	1186.5	146.5	144.0	38.1
ACCESSORY CASE	448.8	209.8	262.0	264.0	13.7
BACKSHOP 180	1286.6	446.4	144.5	144.0	21.2
BACKSHOP 397	673.9	680.2	262.0	264.0	20.7
BEARING HSG.	492.2	108.4	145.5	144.0	8.2
COMB. CHAMBER LNG.	728.4	172.8	142.5	144.0	12.0
COMPRESSOR INLET	1626.2	1086.5	260.5	264.0	49.0
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MATPSI 180 ONLY	5099.1	903.1	95.5	144.0	85.0
MATPSI 397 ONLY	5184.8	911.6	170.5	264.0	156.1
TORUS TURBINE	1027.1	389.5	143.5	144.0	17.0
TURBINE BRG. HSG.	2564.3	2156.7	255.5	264.0	78.1
TURBINE NOZZLE 180	[illegible]	1303.6	142.0	144.0	29.1
TURBINE NOZZLE 397	1795.1	1762.4	256.0	264.0	58.9
WHEEL&SHAFTASSY.	1993.1	806.8	145.0	144.0	33.3

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EXPERIMENTATION RESULTS

The following section describes the results shown by examining the inputs to and the outputs from experimentation:

BEARING HOUSING - Moving the bearing housing in-house makes sense because of the large amount of time the parts sit in backshops waiting to be worked. Moving the work in house can remove most of the waiting time since the part is now most worked under GTE control. The results effect flowtimes of the bearing housing, but not the overall GTE flow times because other subassemblies have longer flowtimes.

INDUCTIONS - Inducting the GTEs at the beginning of the month adds about 4 days to the flowtime, since there is a large number of GTEs at once waiting for disassembly [but excluding the time spent waiting for subassemblies, processing flowtime increases by about 40%]. It is better to spread the inductions over the course of the month. Weekly inductions would ease the strain on inducting large numbers at the beginning of the month.

MANPOWER - Manpower was reduced for in-house personnel in building 329. While the 10% reduction showed little effect , a 20% reduction shows an effect. Mainly the incoming inspectors are affected, since they are the highest utilized in the model.

WORKLOAD - Increasing the workload by 50% has little effect, but increasing it by 100% has a large effect. Again, the incoming inspectors are they bottleneck. If the workload were to increase above 50%, either the inspectors will have to inspect faster or their number should be increased. It appears from the historical data that personnel in the MATPNC area do much of the inspection of the parts anyway. If the workload were to increase, PNC may be able to formally share in the inspection of the parts.

REJECT RATE - Decreasing the reject rate improves the model flowtimes. The effect is small because the most of the flowtime for a GTE is spent waiting [in the model] for its subcomponents. While the effect in the model is small, the effect on the GTE production process would be large because of the scrambling that occurs at the end of every month to meet the monthly production goals.

WORK IN PROCESS - Finished subcomponents were put into the model to show the effect of overinducting GTEs so that a "good" part can be stripped off a GTE in order to put on a GTE that is almost ready to be sold. The effect is to reduce the overall flowtime for a GTE, but to increase the overall number of subcomponents in the model. When over-induction occurs over a large period of time, a large amount of work in process occurs.

SUMMARY

Much of the effects from experimentation were obscured by the fact that most of the flowtime for a subcomponent is spent sitting idle. Less than 5% of the time is needed for processing. Most of the idle time is spent in backshops that GTE has no control over. The historical data suggests that the excessive flowtimes are due to a lack of coordination arising from a part travelling all over the base to many different backshops rather than waiting for busy equipment or manpower. Since the backshops service a large number of customers [often with the GTE workload a small part of their entire workload], they have little incentive to produce the needed parts in a timely matter.

Moving the work in-house to the GTE area would provide GTE control over the process and would reduce the subassembly flowtimes drastically [an estimated reduction of 60-85%]. Most of the large current WIP would not be needed to support monthly production and over-inductions in order to meet production goals would not be needed if the work was performed in-house in building 329.

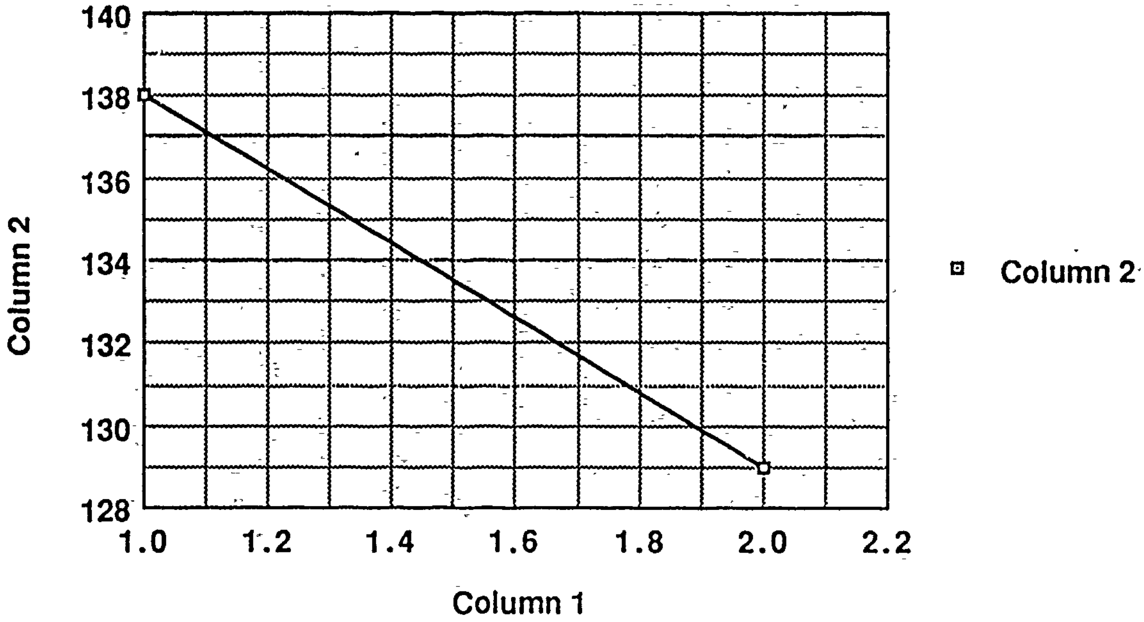
If the manpower and machines currently being used in the backshops were to be transferred to GTEs, the only additional cost would be the moving cost. As much of the work as possible should be moved in house. An informal JIT-pull system currently exists [supervisors try to "pull" critical parts out of the backshop], but a more formal one could be set up if more of the work were to performed in-house.

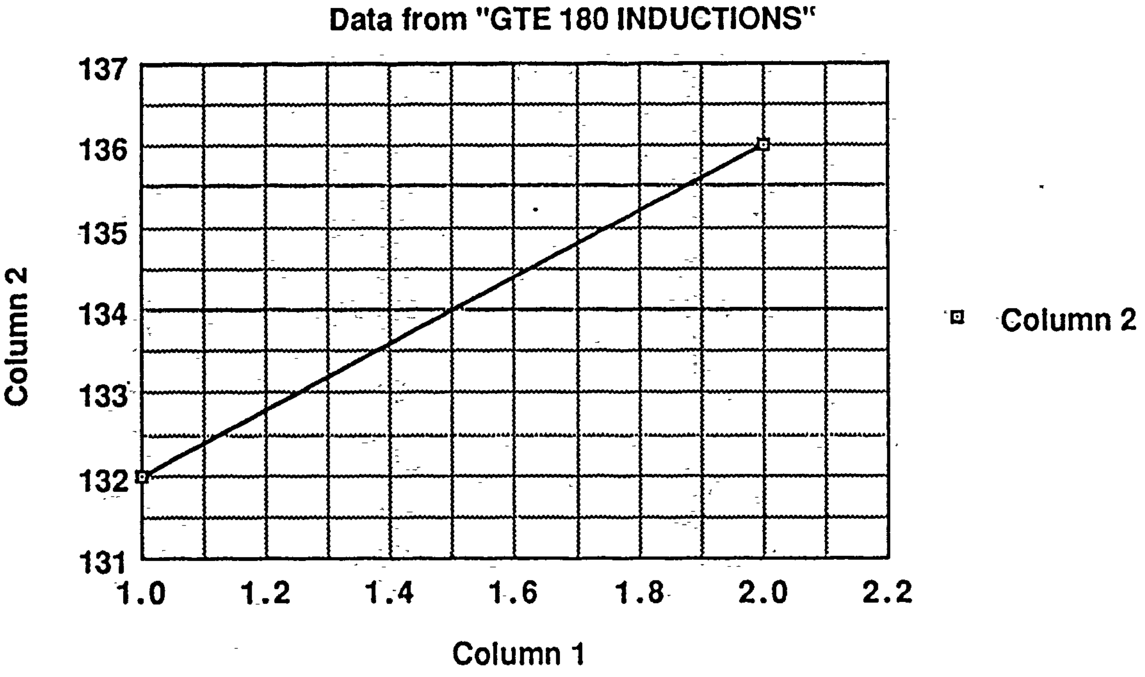
An automated part tracking system would greatly aid in the management of the in-house work, since problem areas could be identified quickly [areas where critical parts are waiting] and management would have the ability to resolve the problems. For the same reasons an automated part tracking system would greatly aid in the management of the current in-house work.

Currently inductions are such that a large number of GTEs are disassembled at the beginning of the month, and a large number are assembled and sold at the end of the month. This results in manpower and equipment that is highly utilized part of the time and idle the much of the time. Inducting GTEs on a weekly schedule and selling them on a weekly schedule would smooth the demand on resources and increase production [rather than being idle due to a lack of work at the beginning of the month, personnel could be working on selling GTEs.

Smoothing inductions and sells, bring work in-house and adding an automated part tracking system could increase GTE production by 20-30% and quality by 40%.

Data from "GTE 180 BRG HSG"

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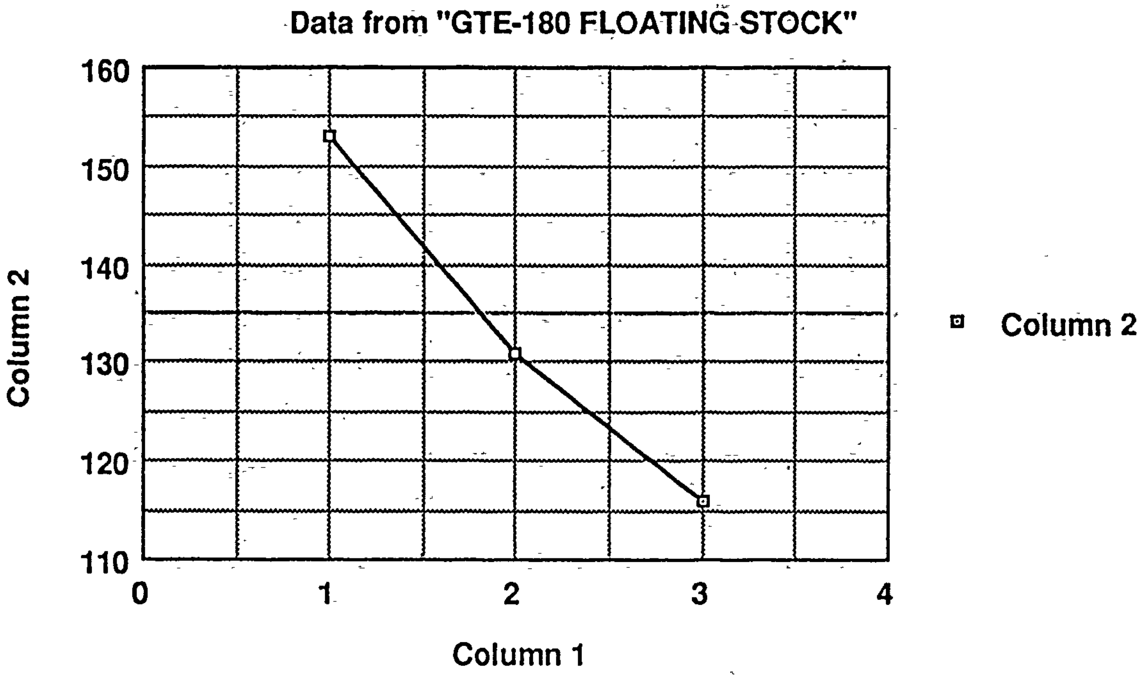
Column 2

615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2
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4
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616

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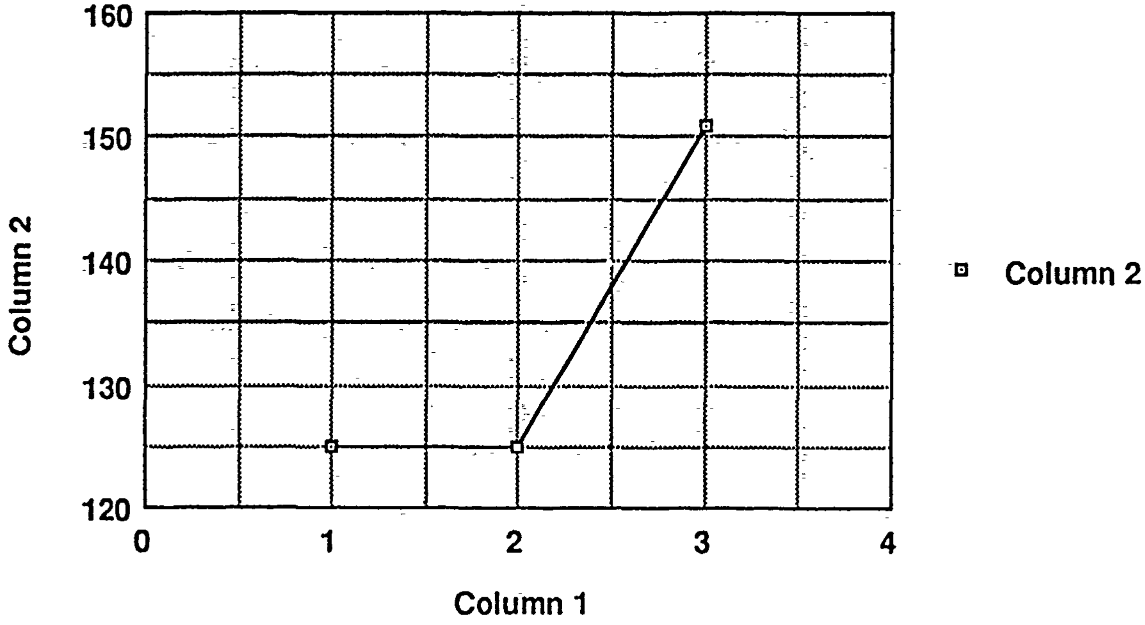

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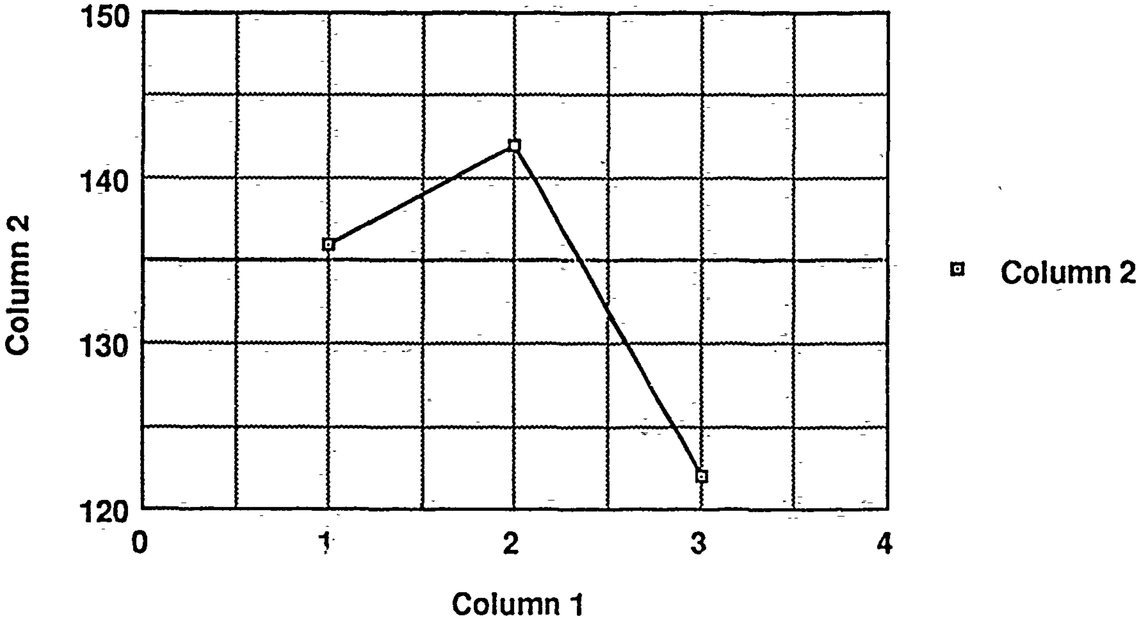

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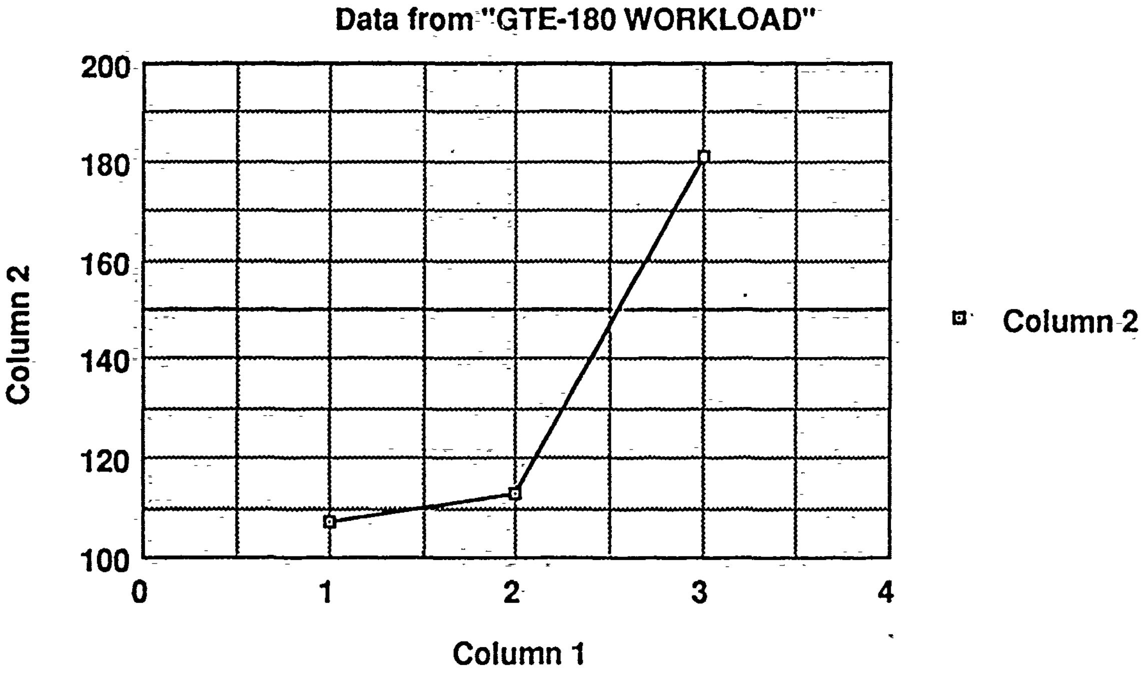
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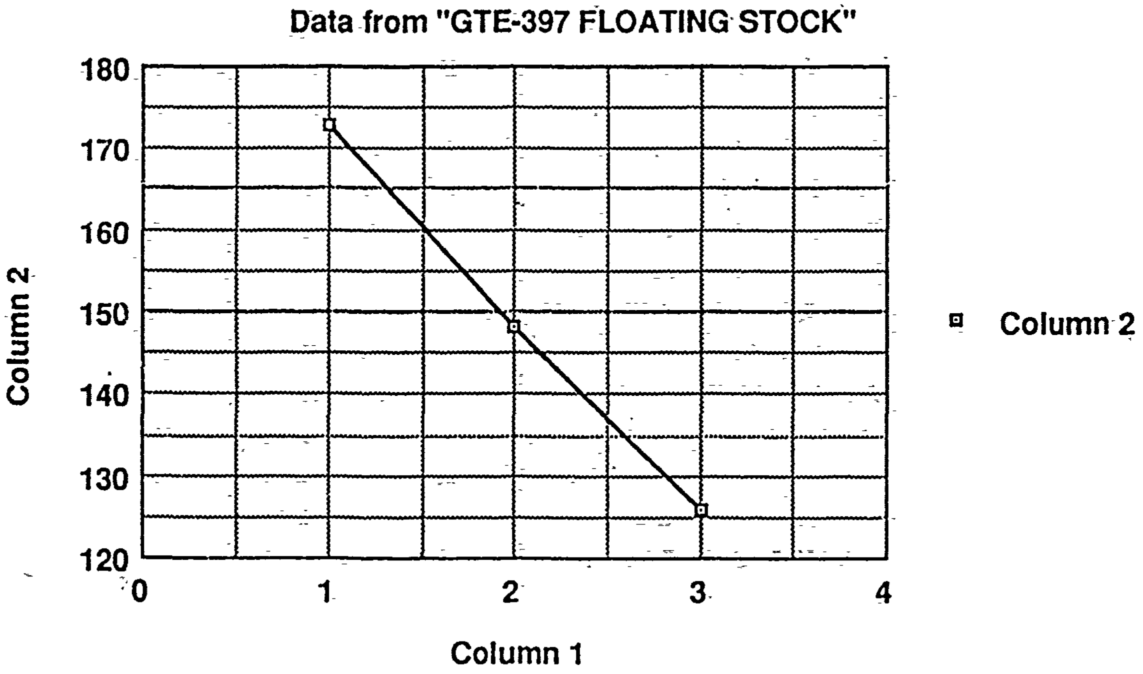
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2
3
4
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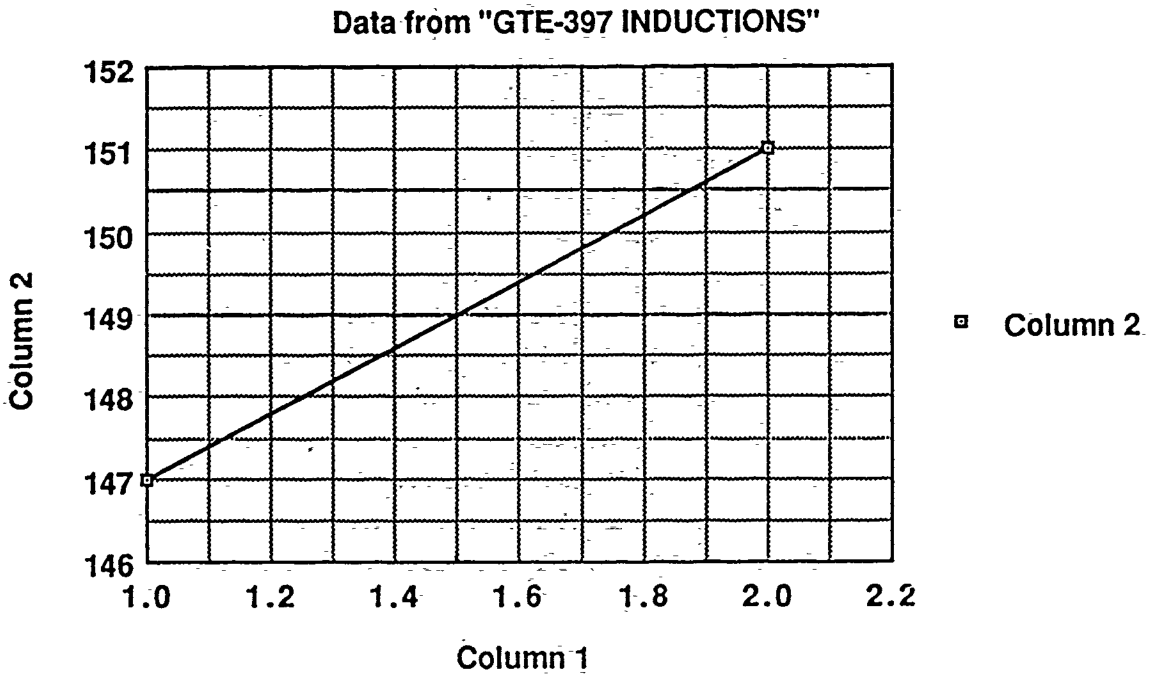
Column 2
□ Column 2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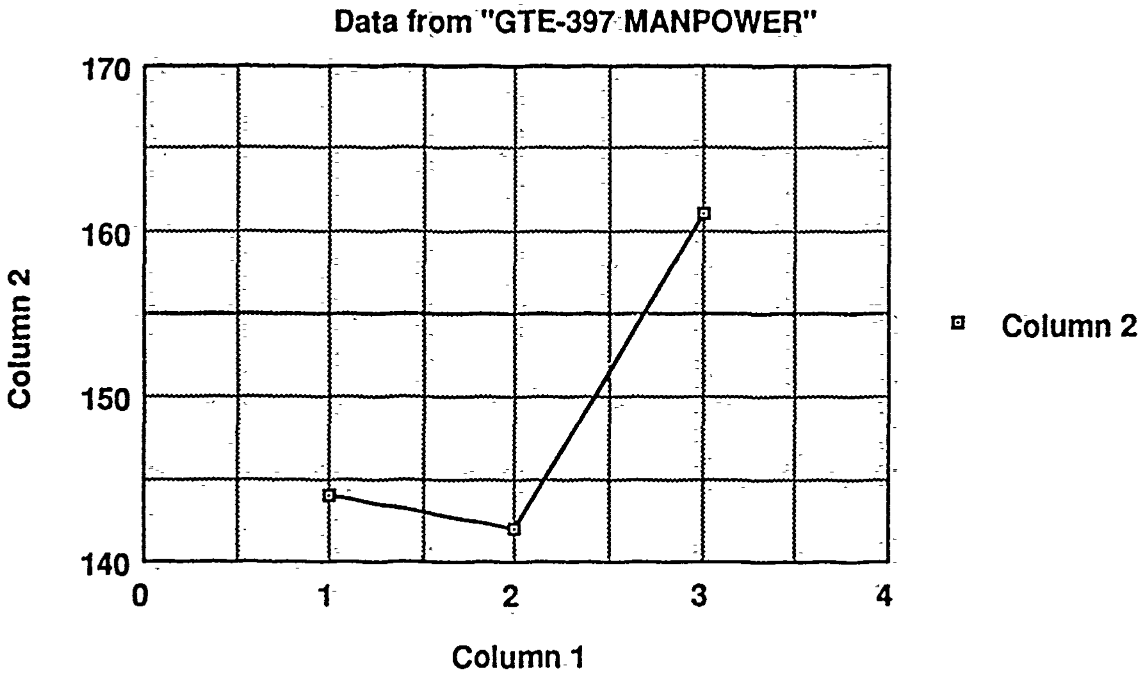
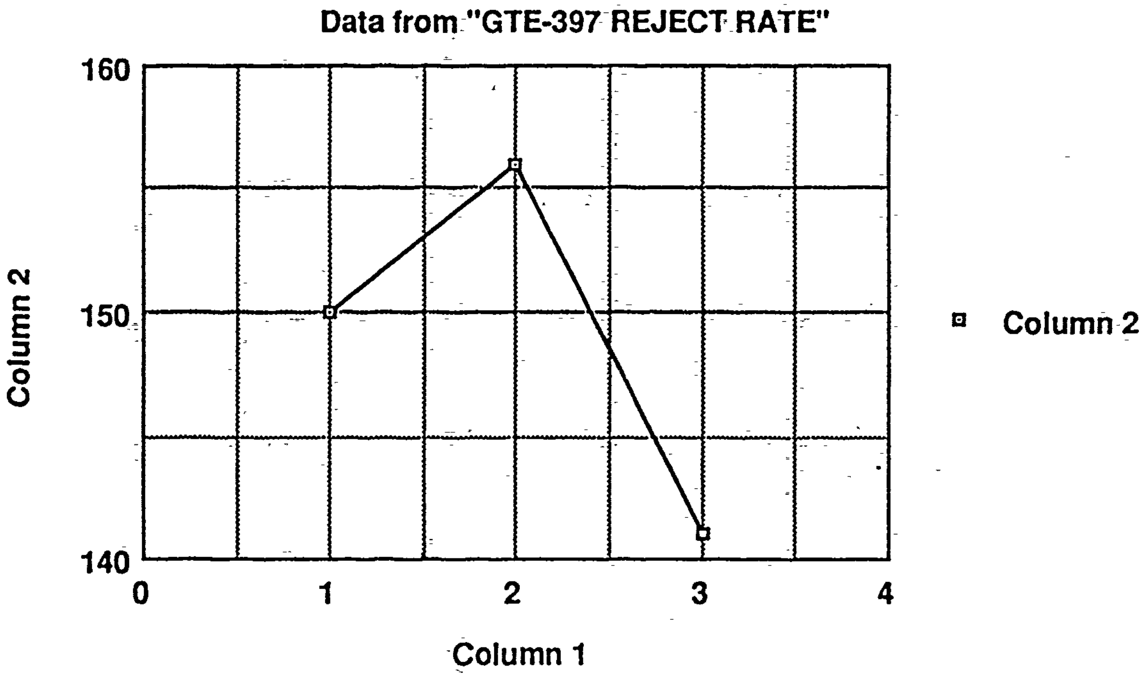
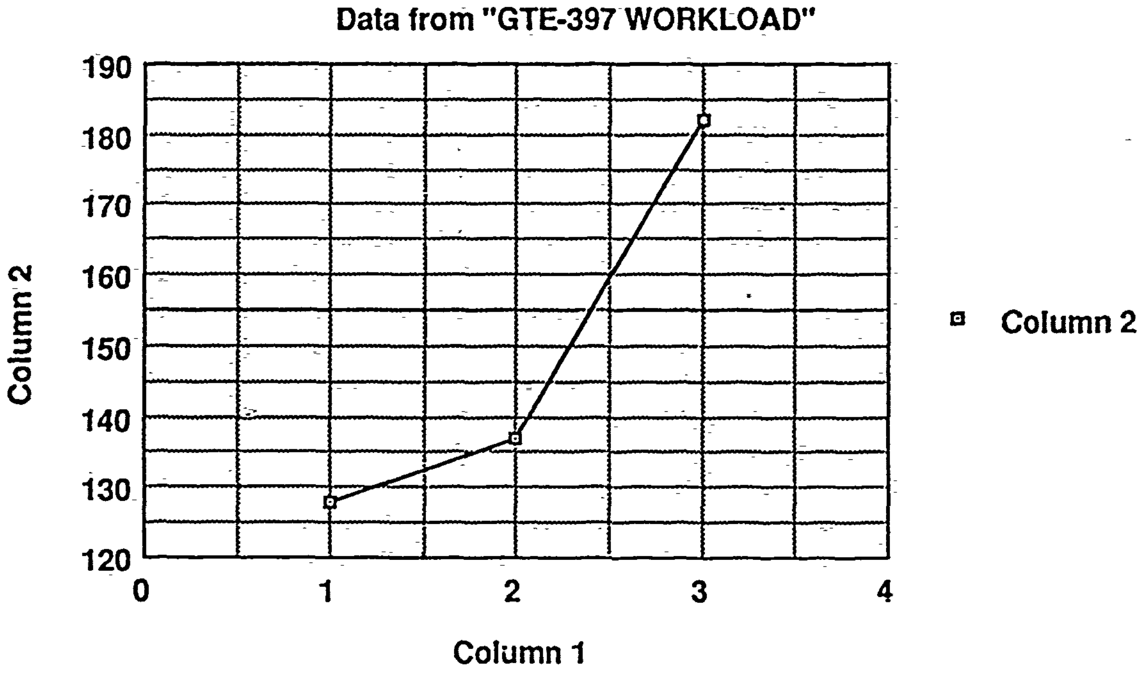
152
151
150
149
148
147
146
1.0
1.2
1.4
1.6
1.8
2.0
2.2
Column 2
Column 1
Column 2


Data from "GTE-397 MANPOWER"
170
160
150
140
0
1
2
3
4
Column 2
Column 1
Column 2


Data from "GTE-397 REJECT RATE"
160
150
140
0
1
2
3
4
Column 1
Column 2
Column 2


Data from "GTE-397 WORKLOAD"
190
180
170
160
150
140
130
120
0
1
2
3
4
Column 2
Column 1
Column 2

DESCRIPTION OF EXPERIMENT

Title of Experiment:
TO 15 GTE-180 WORK IN PROCESS (L4)
Goal/Objective:
ESTIMATE EFFECTS OF CHANGES IN GTE REPAIR PROCESS
Procedure:
EXPERIMENTS CONDUCTED USING THE UDOS 2.0 SIMULATION MODEL
Standard Orthogonal Array Model Used: L4-2-3

Col.	Label	Description of factor	Level 1	Level 2	Level 3	Level 4
1	1	BEARING HSG LOCATION	AS IS	BLDG 329		
2	2	INDUCTION SCHEDULES	AS IS	MONTHLY		
3	3	INTERACTION 1X2	1	2		

EXPERIMENT RESULTS

[9 Trial(s) per Experiment]

Experiment #1:	25	33	57	19	37
	69	23	34	88	
Experiment #2:	25	36	58	18	35
	70	24	36	93	
Experiment #3:	21	31	54	17	31
	66	20	34	88	
Experiment #4:	23	31	59	17	33
	69	19	35	90	

ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)
1	1	49	49	.08	0	0 %
2	1	16	16	.03	0	0 %
3	1	.4	.4	0	0	0 %
e	32	19083.6	596.4		19149	100 %
Total	35	19149				100.00 %

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-180 WORK IN PROCESS (L4)
Number of experiments = 36
Sum (experiment values) = 1518
Correction Factor = 64009
Sum of sqs (experiment values) = 19149

RESPONSE TABLE

Factor:	1	2	3
LEVEL 1	780	747	761
LEVEL 2	738	771	757

RESPONSE TABLE (AVERAGES)

Factor:	1	2	3
LEVEL 1	43.3	41.5	42.3
LEVEL 2	41	42.8	42.1

MAIN EFFECTS ANALYSIS

TO 15 GTE-180 WORK IN PROCESS (L4)
Quality Characteristic: ... the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
BEARING HSG LOCATION	BLDG 329	2	41
INDUCTION SCHEDULES	AS IS	1	41.5
INTERACTION 1X2	2	2	42.1

Total Contribution from significant factors = 124.6
Average Total for all results = 42.2
Estimate of average result (optimum) = 40.3

S/N RATIO TABLE

Experiment	S/N Ratio (db)
1	-33.7
2	-33.9
3	-33.3
4	-33.6

TO 15 GTE-180 WORK IN PROCESS (L4)

S/N ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)	
1	1	.1	.1	--	.1	52.57	%
2	1	.1	.1	--	.1	46.91	%
3	1	.001	.001	--	.001	.52	%
e	0	0	--		0	0	%
Total	3	.2				100.00	%

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-180 WORK IN PROCESS (L4)
Number of experiments = 4
Sum (experiment values) = -134.5
Correction Factor = 4524
Sum of sqs (experiment values) = .2

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S/N RESPONSE TABLE

Factor:	1	2	3
LEVEL 1	-67.6	-67	-67.3
LEVEL 2	-66.9	-67.6	-67.2

S/N RESPONSE TABLE (AVERAGES)

Factor:	1	2	3
LEVEL 1	-33.8	-33.5	-33.6
LEVEL 2	-33.5	-33.8	-33.6

S/N MAIN EFFECTS ANALYSIS

TO 15 GTE-180 WORK IN PROCESS (L4)
Quality Characteristic: ... the smaller the better ......

Significant Factors	Optimum Settings	Level #	Contribution
BEARING HSG LOCATION	BLDG 329	2	-33.5
INDUCTION SCHEDULES	AS IS	1	-33.5
INTERACTION 1X2	2	2	-33.6

Total Contribution from significant factors = -100.6
Average Total for all results = -33.6
Estimate of average result (optimum) = -33.3

DESCRIPTION OF EXPERIMENT

Title of Experiment:
TO 15 GTE-397 WORK IN PROCESS (L4)
Goal/Objective:
ESTIMATE EFFECTS OF CHANGES IN GTE REPAIR PROCESS
Procedure:
EXPERIMENTS CONDUCTED USING THE UDOS 2.0 SIMULATION MODEL
Standard Orthogonal Array Model Used: L4-2-3

Col.	Label	Description of factor	Level 1	Level 2	Level 3	Level 4
1	1	BEARING HSG LOCATION	AS IS	BLDG 329		
2	2	INDUCTION SCHEDULES	AS IS	MONTHLY		
3	3	INTERACTION 1X2	1	2		

EXPERIMENT RESULTS

[9 Trial(s) per Experiment]

Experiment #1:	53	76	108	37	80
	129	46	69	161	
Experiment #2:	54	75	108	38	79
	131	48	71	170	
Experiment #3:	54	75	102	38	81
	124	49	70	160	
Experiment #4:	54	77	111	39	82
	129	49	69	165	

ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)	
1	1	.7	.7	0	0	0	%
2	1	38	38	.02	0	0	%
3	1	1.4	1.4	0	0	0	%
e	32	54108.9	1690.9		54149	100	%
Total	35	54149				100.00	%

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-397 WORK IN PROCESS (L4)

Number of experiments = 36

Correction Factor = 260270

Sum (experiment values) = 3061

Sum of sqs (experiment values) = 54149

RESPONSE TABLE

Factor:	1	2	3
LEVEL 1	1533	1512	1534
LEVEL 2	1528	1549	1527

RESPONSE TABLE (AVERAGES)

Factor:	1	2	3
LEVEL 1	85.2	84	85.2
LEVEL 2	84.9	86.1	84.8

MAIN EFFECTS ANALYSIS

TO 15 GTE-397 WORK IN PROCESS (L4)
Quality Characteristic: ... the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
BEARING HSG LOCATION	BLDG 329	2	84.9
INDUCTION SCHEDULES	AS IS	1	84
INTERACTION 1X2	2	2	84.8

Total Contribution from significant factors = 253.7
Average Total for all results = 85
Estimate of average result (optimum) = 83.6

S/N RATIO TABLE

Experiment	S/N Ratio (db)
1	-39.3
2	-39.6
3	-39.2
4	-39.5

TO 15 GTE-397 WORK IN PROCESS (L4)

S/N ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)	
1	1	.007	.007	- -	.007	10.4	%
2	1	.1	.1	- -	.1	87.33	%
3	1	.002	.002	- -	.002	2.27	%
e	0	0	- -		0	0	%
Total	3	.1				100.00	%

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-397 WORK IN PROCESS (L4)

Number of experiments = 4

Correction Factor = 6212.6

Sum (experiment values) = -157.6

Sum of sqs (experiment values) = .1

S/N RESPONSE TABLE

Factor:	1	2	3
LEVEL 1	-78.9	-78.6	-78.9
LEVEL 2	-78.7	-79.1	-78.8

S/N RESPONSE TABLE (AVERAGES)

Factor:	1	2	3
LEVEL 1	-39.5	-39.3	-39.4
LEVEL 2	-39.4	-39.5	-39.4

S/N MAIN EFFECTS ANALYSIS

TO 15 GTE-397 WORK IN PROCESS (L4)
Quality Characteristic: ... the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
BEARING HSG LOCATION	BLDG 329	2	-39.4
INDUCTION SCHEDULES	AS IS	1	-39.3
INTERACTION 1X2	2	2	-39.4

Total Contribution from significant factors = -118.1
Average Total for all results = -39.4
Estimate of average result (optimum) = -39.3

EXPERIMENT RESULTS [9 Trial(s) per Experiment]

TITLE: TO 15 GTE -397 FLOWTIME (L4)

Experiment # 1:	3500	3296	3518	2466	3481
	4210	3021	3009	5285	
Experiment # 2:	3597	3290	3523	2541	3472
	4293	3149	3117	5575	
Experiment # 3:	3539	3275	3319	2537	3511
	4041	3218	3024	5315	
Experiment # 4:	3562	3385	3633	2584	3637
	4234	3227	3035	5425	

DESCRIPTION OF EXPERIMENT

Title of Experiment:
TO 15 GTE -397 FLOWTIME (L4)
Standard Orthogonal Array Model Used: L4-2-3

Col.	Label	Description of factor	Level 1	Level 2	Level 3	Level 4
1	1	BEARING HSG LOCATION	AS IS	BLDG 329		
2	2	INDUCTION SCHEDULES	AS IS MONTHLY	MONTHLY		
3	3	INTERACTION 1X2	1	2		

EXPERIMENT RESULTS

[9 Trial(s) per Experiment]

Experiment #1 :	3500	3296	3518	2466	3481
	4210	3021	3009	5285	
Experiment #2 :	3597	3290	3523	2541	3472
	4293	3149	3117	5575	
Experiment #3 :	3539	3275	3319	2537	3511
	4041	3218	3024	5315	
Experiment #4 :	3562	3385	3633	2584	3637
	4234	3227	3035	5425	

ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)
1	1	693.4	693.4	0	0	0 %
2	1	81605.4	81605.4	.12	0	0 %
3	1	821.8	821.8	0	0	0 %
e	32	21476495.3	671140.5		21559616	100 %
Total	35	21559616				100.00 %

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE -397 FLOWTIME (L4)
Number of experiments = 36
Sum (experiment values) = 128844
Correction Factor = 461132676
Sum of sqs (experiment values) = 21559616

RESPONSE TABLE

Factor:	1	2	3
LEVEL 1	64343	63565	64508
LEVEL 2	64501	65279	64336

RESPONSE TABLE (AVERAGES)

Factor:	1	2	3
LEVEL 1	3574.6	3531.4	3583.8
LEVEL 2	3583.4	3626.6	3574.2

MAIN EFFECTS ANALYSIS

TO 15 GTE -397 FLOWTIME (L4)
Quality Characteristic: ... the smaller the better ...

Significant Factors.	Optimum Settings	Level #	Contribution
BEARING HSG LOCATION	AS IS	1	3574.6
INDUCTION SCHEDULES	AS IS MONTHLY	1	3531.4
INTERACTION 1X2	2	2	3574.2

Total Contribution from significant factors =	10680.2
Average Total for all results =	3579
Estimate of average result (optimum) =	3522.2

S/N RATIO TABLE

Experiment	S/N Ratio (db)
1	-71.2
2	-71.4
3	-71.1
4	-71.4

TO 15 GTE -397 FLOWTIME (L4)

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S/N ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)	
1	1	0	0	- -	0	0	%
2	1	.1	.1	- -	.1	99.63	%
3	1	0	0	- -	0	.37	%
e	0	0	- -		0	0	%
Total	3	.1				100.00	%

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE -397 FLOWTIME (L4)

Number of experiments = 4

Sum (experiment values) = -285.1

Correction Factor = 20318.8

Sum of sqs (experiment values) = .1

642

S/N RESPONSE TABLE

Factor:	1	2	3
LEVEL 1	-142.5	-142.3	-142.6
LEVEL 2	-142.5	-142.8	-142.5

S/N RESPONSE TABLE (AVERAGES)

Factor:	1	2	3
LEVEL 1	-71.3	-71.2	-71.3
LEVEL 2	-71.3	-71.4	-71.3

S/N MAIN EFFECTS ANALYSIS

TO 15 GTE -397 FLOWTIME (L4)
Quality Characteristic: ... the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
BEARING HSG LOCATION	BLDG 329	2	-71.3
INDUCTION SCHEDULES	AS IS MONTHLY	1	-71.2
INTERACTION 1X2	2	2	-71.3

Total Contribution from significant factors = -213.8
Average Total for all results = -71.3
Estimate of average result (optimum) = -71.2

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--------------------------------------------------------------------------------
            EXPERIMENT   RESULTS                      [ 9  Trial(s) per Experiment ]
--------------------------------------------------------------------------------
TITLE: TO 15 GTE-180 FLOWTIME (L4)
--------------------------------------------------------------------------------
Experiment  # 1 :  3049      2673      3389      2317      2979
                   4111      2865      2694      5289
................................................................................
Experiment  # 2 :  3051      2908      3569      2182      2790
                   4277      2932      2904      5735
................................................................................
Experiment  # 3 :  2659      2512      3240      2128      2467
                   3969      2477      2709      5286
................................................................................
Experiment  # 4 :  2733      2500      3597      2029      2666
                   4211      2309      2766      5450
................................................................................
```

DESCRIPTION OF EXPERIMENT

Title of Experiment:
TO 15 GTE-180 FLOWTIME (L4)
Standard Orthogonal Array Model Used: L4-2-3

Col.	Label	Description of factor	Level 1	Level 2	Level 3	Level 4
1	1	BEARING HSG LOCATION	AS IS	BLDG 329		
2	2	INDUCTION SCHEDULES	AS IS	MONTHLY		
3	3	INTERACTION 1X2	1	2		

EXPERIMENT RESULTS [9 Trial(s) per Experiment]

Experiment # 1 :	3049	2673	3389	2317	2979
	4111	2865	2694	5289	
Experiment # 2 :	3051	2908	3569	2182	2790
	4277	2932	2904	5735	
Experiment # 3 :	2659	2512	3240	2128	2467
	3969	2477	2709	5286	
Experiment # 4 :	2733	2500	3597	2029	2666
	4211	2309	2766	5450	

ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)	
1	1	445778.8	445778.8	.43	0	0	%
2	1	89600.4	89600.4	.09	0	0	%
3	1	784	784	0	0	0	%
e	32	33132613.8	1035394.2		33668777	100	%
Total	35	33668777				100.00	%

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-180 FLOWTIME (L4)
Number of experiments = 36
Sum (experiment values) = 115422
Correction Factor = 370062169
Sum of sqs (experiment values) = 33668777

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RESPONSE TABLE

Factor:	1	2	3
LEVEL	59714	56813	57627
LEVEL 2	55708	58609	57795

RESPONSE TABLE (AVERAGES)

Factor:	1	2	3
LEVEL 1	3317.4	3156.3	3201.5
LEVEL 2	3094.9	3256.1	3210.8

MAIN EFFECTS ANALYSIS

TO 15 GTE-180 FLOWTIME (L4)
Quality Characteristic: ... the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
BEARING HSG LOCATION	BLDG 329	2	3094.9
INDUCTION SCHEDULES	AS IS	1	3156.3
INTERACTION 1X2	1	1	3201.5

Total Contribution from significant factors = 9452.7
Average Total for all results = 3206.2
Estimate of average result (optimum) = 3040.4

S/N RATIO TABLE

Experiment	S/N Ratio (db)
1	-70.6
2	-70.9
3	-70.1
4	-70.4

TO 15 GTE-180 FLOWTIME (L4)

S/N ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)
1	1	.3	.3	- -	.3	70.54 %
2	1	.1	.1	- -	.1	29.27 %
3	1	.001	.001	- -	.001	.18 %
e	0	0	- -		0	0 %
Total	3	.4				100.00 %

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-180 FLOWTIME (L4)
Number of experiments = 4
Sum (experiment values) = -281.9
Correction Factor = 19873.8
Sum of sqs (experiment values) = .4

S/N RESPONSE TABLE

Factor:	1	2	3
LEVEL 1	-141.5	-140.6	-140.9
LEVEL 2	-140.5	-141.3	-141

S/N RESPONSE TABLE (AVERAGES)

Factor:	1	2	3
LEVEL 1	-70.7	-70.3	-70.5
LEVEL 2	-70.2	-70.7	-70.5

S/N MAIN EFFECTS ANALYSIS

TO 15 GTE-180 FLOWTIME (L4)
Quality Characteristic: ... the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
BEARING HSG LOCATION	BLDG 329	2	-70.2
INDUCTION SCHEDULES	AS IS	1	-70.3
INTERACTION 1X2	1	1	-70.5

Total Contribution from significant factors = -211
Average Total for all results = -70.5
Estimate of average result (optimum) = -70

EXPERIMENT RESULTS [4 Trial(s) per Experiment]

TITLE: TO 15 GTE-180 (L9)

	Trial # 1	Trial # 2	Trial # 3	Trial # 4
Experiment # 1:	3049	3051	2659	2733
Experiment # 2:	2673	2908	2512	2500
Experiment # 3:	3389	3569	3240	3597
Experiment # 4:	2317	2182	2128	2029
Experiment # 5:	2979	2790	2467	2666
Experiment # 6:	4111	4277	3969	4211
Experiment # 7:	2865	2932	2477	2309
Experiment # 8:	2694	2904	2709	2766
Experiment # 9:	5289	5735	5286	5450

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DESCRIPTION OF EXPERIMENT

Title of Experiment:
TO 15 GTE-180 (L9)
Goal/Objective:
EVALUATE THE EFFECTS OF CHANGES IN THE GTE REPAIR PROCESS
Procedure:
EXPERIMENTS CONDUCTED USING THE UDOS 2.0 SIMULATION MODEL
Standard Orthogonal Array Model Used: L9-3-4

Col.	Label	Description of factor	Level 1	Level 2	Level 3	Level 4
1	1	MANPOWER	AS IS	-10%	-20%	
2	2	WORKLOAD	AS IS	+50%	+100%	
3	3	REJECTION RATE	AS IS	-12%	0%	
4	4	FLOATING STOCK (WIP)	AS IS	+10%	+30%	

EXPERIMENT RESULTS [4 Trial(s) per Experiment]

	Trial #1	Trial #2	Trial #3	Trial #4
Experiment #1:	3049	3051	2659	2733
Experiment #2:	2673	2908	2512	2500
Experiment #3:	3389	3569	3240	3597
Experiment #4:	2317	2182	2128	2029
Experiment #5:	2979	2790	2467	2666
Experiment #6:	4111	4277	3969	4211
Experiment #7:	2865	2932	2477	2309
Experiment #8:	2694	2904	2709	2766
Experiment #9:	5289	5735	5286	5450

ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)	
1	2	3055442	1527721	41.7	2982170.4	8.86	%
2	2	23427507.2	11713753.6	319.74	23354235.6	69.36	%
3	2	1421845.2	710922.6	19.41	1348573.6	4.01	%
4	2	4774816.7	2387408.3	65.17	4701545.1	13.96	%
e	27	989166	36635.8		1282252.2	3.81	%
Total	35	33668777				100.00	%

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-180 (L9)

Number of experiments = 36

Sum (experiment values) = 115422

Correction Factor = 370062169

Sum of sqs (experiment values) = 33668777

RESPONSE TABLE

Factor:	1	2	3	4
LEVEL 1	35880	30731	39133	44154
LEVEL 2	36126	32568	41009	37744
LEVEL 3	43416	52123	35280	33524

RESPONSE TABLE (AVERAGES)

Factor:	1	2	3	4
LEVEL 1	2990	2560.9	3261.1	3679.5
LEVEL 2	3010.5	2714	3417.4	3145.3
LEVEL 3	3618	4343.6	2940	2793.7

MAIN EFFECTS ANALYSIS

TO 15 GTE-180 (L9)
Quality Characteristic: .....the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
MANPOWER	AS IS	1	2990
WORKLOAD	AS IS	1	2560.9
REJECTION RATE	0%	3	2940
FLOATING STOCK (WIP)	+30%	3	2793.7

Total Contribution from significant factors = 11284.6
Average Total for all results = 3206.2
Estimate of average result (optimum) = 1666.1

S/N RATIO TABLE

Experiment	S/N Ratio (db)
1	-69.2
2	-68.5
3	-70.8
4	-66.7
5	-68.7
6	-72.3
7	-68.5
8	-68.8
9	-74.7

TO 15 GTE-180 (L9)

S/N ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)
1	2	3.5	1.8	- -	3.5	7.52 %
2	2	35.8	17.9	- -	35.8	76.08 %
3	2	1.1	.5	- -	1.1	2.29 %
4	2	6.6	3.3	- -	6.6	14.11 %
e	0	0	- -		0	0 %
Total	8	47				100.00 %

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-180 (L9)

Number of experiments = 9

Sum (experiment values) = -628.3

Correction Factor = 43858.1

Sum of sqs (experiment values) = 47

S/N. RESPONSE TABLE

Factor:	1	2	3	4
LEVEL 1	-208.4	-204.4	-210.4	-212.6
LEVEL 2	-207.8	-206.1	-209.9	-209.3
LEVEL 3	-212.1	-217.8	-208	-206.3

S/N RESPONSE TABLE (AVERAGES)

Factor:	1	2	3	4
LEVEL 1	-69.5	-68.1	-70.1	-70.9
LEVEL 2	-69.3	-68.7	-70	-69.8
LEVEL 3	-70.7	-72.6	-69.3	-68.8

S/N MAIN EFFECTS ANALYSIS

TO 15 GTE-180 (L9)
Quality Characteristic: ... the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
MANPOWER	-10%	2	-69.3
WORKLOAD	AS IS	1	-68.1
REJECTION RATE	0%	3	-69.3
FLOATING STOCK (WIP)	+30%	3	-68.8

Total Contribution from significant factors = -275.5
Average Total for all results = -69.8
Estimate of average result (optimum) = -66.1

DESCRIPTION OF EXPERIMENT

Title of Experiment:
TO 15 GTE-397 (L9) FLOWTIM
Goal/Objective:
EVALUATE THE EFFECTS OF CHANGES IN THE GTE REPAIR PROCESS
Procedure:
EXPERIMENTS CONDUCTED USING THE UDOS 2.0 SIMULATION MODEL
Standard Orthogonal Array Model Used: L9-3-4

Col.	Label	Description of factor	Level 1	Level 2	Level 3	Level 4
1	1	MANPOWER	AS IS	-10%	-20%	
2	2	WORKLOAD	AS IS	+50%	+100%	
3	3	REJECT RATE	AS IS	12%	0%	
4	4	FLOATING STOCK (WIP)	AS IS	+10%	+30%	

EXPERIMENT RESULTS

[4 Trial(s) per Experiment]

	Trial # 1	Trial # 2	Trial # 3	Trial # 4
Experiment # 1 :	3500	3597	3539	3562
Experiment # 2 :	3296	3290	3275	3385
Experiment # 3 :	3518	3523	3319	3633
Experiment # 4 :	2466	2541	2537	2584
Experiment # 5 :	3481	3472	3511	3637
Experiment # 6 :	4210	4293	4041	4234
Experiment # 7 :	3021	3149	3218	3227
Experiment # 8 :	3009	3117	3024	3035
Experiment # 9 :	5285	5575	5315	5425

ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)	
1	2	1497242.2	748621.1	96.59	1481740.7	6.87	%
2	2	11378836.2	5689418.1	734.05	11363334.7	52.71	%
3	2	763597.2	381798.6	49.26	748095.7	3.47	%
4	2	7710670.5	3855335.3	497.42	7695169	35.69	%
e	27	209270	7750.7		271275.9	1.26	%
Total	35	21559616				100.00	%

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-397 (L9) FLOWTIM

Number of experiments = 36

Sum (experiment values) = 128844

Correction Factor = 461132676

Sum of sqs (experiment values) = 21559616

```
------------------------------------------------------------------------------------------
                            RESPONSE     TABLE
------------------------------------------------------------------------------------------
Factor:            1           2            3            4
LEVEL  1         41437       36941        43161        49899
LEVEL  2         41007       39532        44974        42639
LEVEL  3         46400       52371        40709        36306
------------------------------------------------------------------------------------------
                        RESPONSE   TABLE  (AVERAGES)
------------------------------------------------------------------------------------------
Factor:            1           2            3            4
LEVEL  1         3453.1      3078.4       3596.8       4158.3
LEVEL  2         3417.3      3294.3       3747.8       3553.3
LEVEL  3         3866.7      4364.3       3392.4       3025.5
------------------------------------------------------------------------------------------
                          MAIN   EFFECTS   ANALYSIS
------------------------------------------------------------------------------------------

TO 15 GTE-397 (L9) FLOWTIM
Quality Characteristic: ... the smaller the better ....
------------------------------------------------------------------------------------------
   Significant Factors            Optimum Settings       Level #     Contribution
------------------------------------------------------------------------------------------
   MANPOWER                       -10%                     2          3417.3
   WORKLOAD                       AS IS                    1          3078.4
   REJECT RATE                    0%                       3          3392.4
   FLOATING STOCK (WIP)           +30%                     3          3025.5
------------------------------------------------------------------------------------------
                          Total Contribution from significant factors =   12913.6
                          Average Total for all results =                 3579
                          Estimate of average result (optimum) =          2176.6
```

S/N RATIO TABLE

Experiment	S/N Ratio (db)
1	-71
2	-70.4
3	-70.9
4	-68.1
5	-70.9
6	-72.5
7	-70
8	-69.7
9	-74.6

TO 15 GTE-397 (L9) FLOWTIM

S/N ANALYSIS OF VARIATION

Factor	Df	Sums of Squares	Variance	F-Ratio	Pure Sum of Sqs.	P(%)
1	2	1.4	.7	- -	1.4	5.24 %
2	2	14.7	7.3	- -	14.7	54.21 %
3	2	.4	.2	- -	.4	1.43 %
4	2	10.6	5.3	- -	10.6	39.12 %
e	0	0	- -		0	0 %
Total	8	27.1				100.00 %

[Note: Insignificant factors are pooled and indicated by parenthesis.]

TO 15 GTE-397 (L9) FLOWTIM
Number of experiments = 9
Sum (experiment values) = -638.1
Correction Factor = 45236.1
Sum of sqs (experiment values) = 27.1

S/N RESPONSE TABLE

Factor:	1	2	3	4
LEVEL 1	-212.3	-209.1	-213.1	-216.6
LEVEL 2	-211.5	-211	-213.1	-212.8
LEVEL 3	-214.3	-218	-211.8	-208.6

S/N RESPONSE TABLE (AVERAGES)

Factor:	1	2	3	4
LEVEL 1	-70.8	-69.7	-71	-72.2
LEVEL 2	-70.5	-70.3	-71	-70.9
LEVEL 3	-71.4	-72.7	-70.6	-69.5

S/N MAIN EFFECTS ANALYSIS

TO 15 GTE-397 (L9) FLOWTIM
Quality Characteristic: ... the smaller the better ...

Significant Factors	Optimum Settings	Level #	Contribution
MANPOWER	-10%	2	-70.5
WORKLOAD	AS IS	1	-69.7
REJECT RATE	0%	3	-70.6
FLOATING STOCK (WIP)	+30%	3	-69.5

Total Contribution from significant factors = -280.3
Average Total for all results = -70.9
Estimate of average result (optimum) = -67.6

GTE - CONFIRMATION RUN 1

RUN#1						RUN #2				
ITEM NAME	FLOW TIME	ST.DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1026.91	547.3	65	70	7.9	1013.12	639.8	72	71	7.9
1ST.STG.INLETASSY.	1645.85	883.3	74	70	12.8	1582.92	867	69	71	12.7
2ND.STG.COMPR.DIFF	1737.46	1025	65	70	13.2	1770.99	1239	70	71	14
2ND.STG.DIFF.ASSY	3070.46	1185	133	130	46	3313.44	1099	122	131	50.4
2ND.STG.DIFF.HSG.	1968.46	1276	66	70	15.4	1864.8	1189	71	71	15.1
2NDSTG.COMPR.HSG.	2382.71	1157	70	70	19.1	2473.19	1302	71	71	20.3
ACCESSORY CASE	449.52	197.1	133	130	6.7	428.39	169.1	131	131	6.4
BACKSHOP 180	1376.96	483.4	71	70	10.6	1363.62	416.7	70	71	11
BACKSHOP 397	688.23	747	128	130	10.4	748.57	976	131	131	11.2
BEARING HSG.	512.38	109.5	67	70	3.9	508.26	110	70	71	4.1
COMB. CHAMBER LNG.	735.32	169.9	66	70	5.6	732.45	178.1	71	71	5.9
COMPRESSOR INLET	1645.91	1199	127	130	24.2	1646.73	1017	122	131	24.1
GTE -180	2089.64	309.1	69	72	16.5	2065.85	323.7	73	72	16.8
GTE -397	2308.69	154.1	132	132	34.5	2490.67	209	122	132	37.9
MATPSI 180 ONLY	787.92	148.4	64	70	6	736.74	141	71	71	5.9
MATPSI 397 ONLY	739.67	146.7	130	130	11.1	729.64	161.3	130	131	10.9
TORUS TURBINE	1052.5	433.6	68	70	8.1	1023.23	436	74	71	8.2
TURBINE BRG. HSG.	2661.23	1942	127	130	39.9	2405.84	1930	133	131	36.7
TURBINE NOZZLE 180	1846.83	1350	68	70	13.2	1515.78	990.9	69	71	12.7
TURBINE NOZZLE 397	1748.46	1541	128	130	26.5	1777.44	1566	138	131	24.7
WHEEL&SHAFTASSY.	2179.01	775.4	73	70	16.8	1893.21	740.6	74	71	15.4

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1020.0	593.6	68.5	70.5	7.9
1ST.STG.INLETASSY.	1614.4	875.2	71.5	70.5	12.8
2ND.STG.COMPR.DIFF	1754.2	1132.2	67.5	70.5	13.6
2ND.STG.DIFF.ASSY	3192.0	1141.7	127.5	130.5	48.2
2ND.STG.DIFF.HSG.	1916.6	1232.6	68.5	70.5	15.3
2NDSTG.COMPR.HSG.	2428.0	1229.5	70.5	70.5	19.7
ACCESSORY CASE	439.0	183.1	132.0	130.5	6.6
BACKSHOP 180	1370.3	450.0	70.5	70.5	10.8
BACKSHOP 397	718.4	861.5	129.5	130.5	10.8
BEARING HSG.	510.3	109.7	68.5	70.5	4.0
COMB. CHAMBER LNG.	733.9	174.0	68.5	70.5	5.8
COMPRESSOR INLET	1646.3	1108.0	124.5	130.5	24.2
GTE -180	2077.7	316.4	71.0	72.0	16.7
GTE -397	2399.7	181.6	127.0	132.0	36.2
MATPSI 180 ONLY	762.3	144.7	67.5	70.5	6.0
MATPSI 397 ONLY	734.7	154.0	130.0	130.5	11.0
TORUS TURBINE	1037.9	434.8	71.0	70.5	8.2
TURBINE BRG. HSG.	2533.5	1936.4	130.0	130.5	38.3
TURBINE NOZZLE 180	1681.3	1170.3	68.5	70.5	13.0
TURBINE NOZZLE 397	1763.0	1553.7	133.0	130.5	25.6
WHEEL&SHAFTASSY.	2036.1	758.0	73.5	70.5	16.1

GTE - CONFIRMATION RUN 2

	RUN#1					RUN #2				
ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	981.86	501.3	68	70	7.4	1036.99	471.9	73	71	8.5
1ST.STG.INLETASSY.	1489.22	739.7	70	70	12.1	1694.17	820.7	71	71	13.7
2ND.STG.COMPR.DIFF	1588.01	1120	73	70	12.5	1559.95	1188	71	71	12.5
2ND.STG.DIFF.ASSY	3389.75	1149	124	130	50.5	3103.89	1067	130	131	46.7
2ND.STG.DIFF.HSG.	2054.71	1345	70	70	15.8	1754.1	1194	66	71	14.9
2NDSTG.COMPR.HSG.	2267.36	1052	78	70	17.2	2292.78	1094	66	71	19.1
ACCESSORY CASE	419.07	193.3	133	130	6.2	446.37	194.2	133	131	6.7
BACKSHOP 180	1198.45	404.1	68	70	9.2	1252.81	425.8	70	71	10.2
BACKSHOP 397	814.3	875	134	130	11.3	637.32	663.7	132	131	9.3
BEARING HSG.	480.46	109.3	65	70	3.7	488.75	105.8	71	71	3.9
COMB. CHAMBER LNG.	714.69	199.9	68	70	5.5	708.3	148.3	70	71	5.7
COMPRESSOR INLET	1676.96	1061	129	130	25	1519.67	919.7	130	131	22.9
GTE -180	1856.02	378	78	72	14.5	1923.33	278.3	65	72	15.8
GTE -397	2556.47	180.5	121	132	38.2	2312.09	184.6	130	132	35
MATPSI 180 ONLY	700.63	123.9	66	70	5.4	767.68	165.9	73	71	6.1
MATPSI 397 ONLY	759.49	152.1	131	130	11.3	768.22	174.4	132	131	11.4
TORUS TURBINE	1026.29	392.6	66	70	7.8	1070.95	368.9	70	71	8.7
TURBINE BRG. HSG.	2462.4	2013	136	130	34.7	2295.17	1906	133	131	39.2
TURBINE NOZZLE 180	1568.48	1314	72	70	12.3	1868.97	1361	70	71	15.2
TURBINE NOZZLE 397	1703.52	1599	142	130	25.5	1946.85	2023	123	131	28.8
WHEEL&SHAFTASSY.	1851.37	691.2	67	70	14.5	1922.63	788.9	74	71	15.4

TWO RUN AVERAGE

ITEM NAME	FLOW TIME	ST DEV	NUM OUT	NUM IN	AVE WIP
1ST.STG.COMPR.DIFF	1009.4	486.6	70.5	70.5	8.0
1ST.STG.INLETASSY.	1591.7	780.2	70.5	70.5	12.9
2ND.STG.COMPR.DIFF	1574.0	1154.1	72.0	70.5	12.5
2ND.STG.DIFF.ASSY	3246.8	1108.1	127.0	130.5	48.6
2ND.STG.DIFF.HSG.	1904.4	1269.8	68.0	70.5	15.4
2NDSTG.COMPR.HSG.	2280.1	1072.7	72.0	70.5	18.2
ACCESSORY CASE	432.7	193.8	133.0	130.5	6.5
BACKSHOP 180	1225.6	415.0	69.0	70.5	9.7
BACKSHOP 397	725.8	769.4	133.0	130.5	10.3
BEARING HSG.	484.6	107.5	68.0	70.5	3.8
COMB. CHAMBER LNG.	711.5	174.1	69.0	70.5	5.6
COMPRESSOR INLET	1598.3	990.4	129.5	130.5	24.0
GTE -180	1889.7	328.2	71.5	72.0	15.2
GTE -397	2434.3	182.5	125.5	132.0	36.6
MATPSI 180 ONLY	734.2	144.9	69.5	70.5	5.8
MATPSI 397 ONLY	763.9	163.3	131.5	130.5	11.4
TORUS TURBINE	1048.6	380.8	68.0	70.5	8.3
TURBINE BRG. HSG.	2378.8	1959.4	134.5	130.5	37.0
TURBINE NOZZLE 180	1718.7	1337.3	71.0	70.5	13.8
TURBINE NOZZLE 397	1825.2	1810.9	132.5	130.5	27.2
WHEEL&SHAFTASSY.	1887.0	740.0	70.5	70.5	15.0

ENGINEERING NOTES

EMPLOYEE GARDNER DATE 19 Sept 90 PAGE NO. 1

RCC MA SUBJECT Labor rates for Cost Savings

Susan Schattle provided the following labor rates! for MA:

Burdened - $62.14/hour

Unburdened - $15.80/hour

Direct mat'l - $20.64/hour

O/H Labor + G&A - $41.50/hour

These are FY 90 planning rates & were obtained from Sylvia Rodreguiz (sp) in MAWBE (Financial Planning)

Susan will coordinate the use of these numbers with HQ AFLC. Unless otherwise advised, MDMSC will estimate the value of labor hour reductions using the unburdened ($15.80) rate.

DDB SECTION CODE 1.0 DDB PAGE NO.

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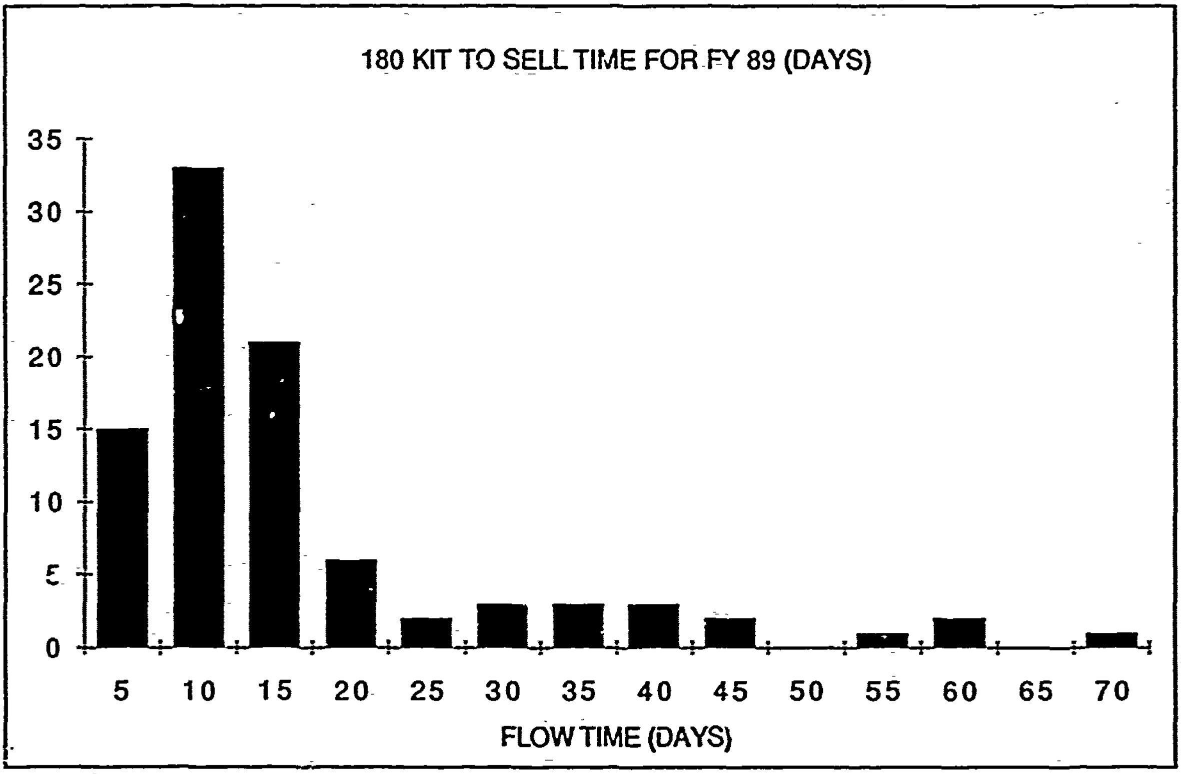
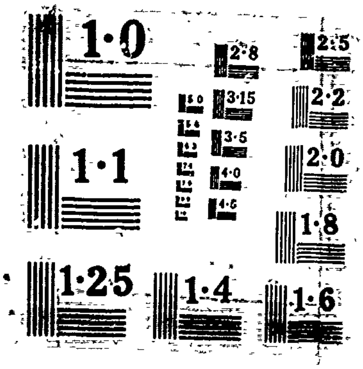
JIT FLOW



$\bar{x} = 14.85$

$s = 13.51$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2·8
2·5
3·15
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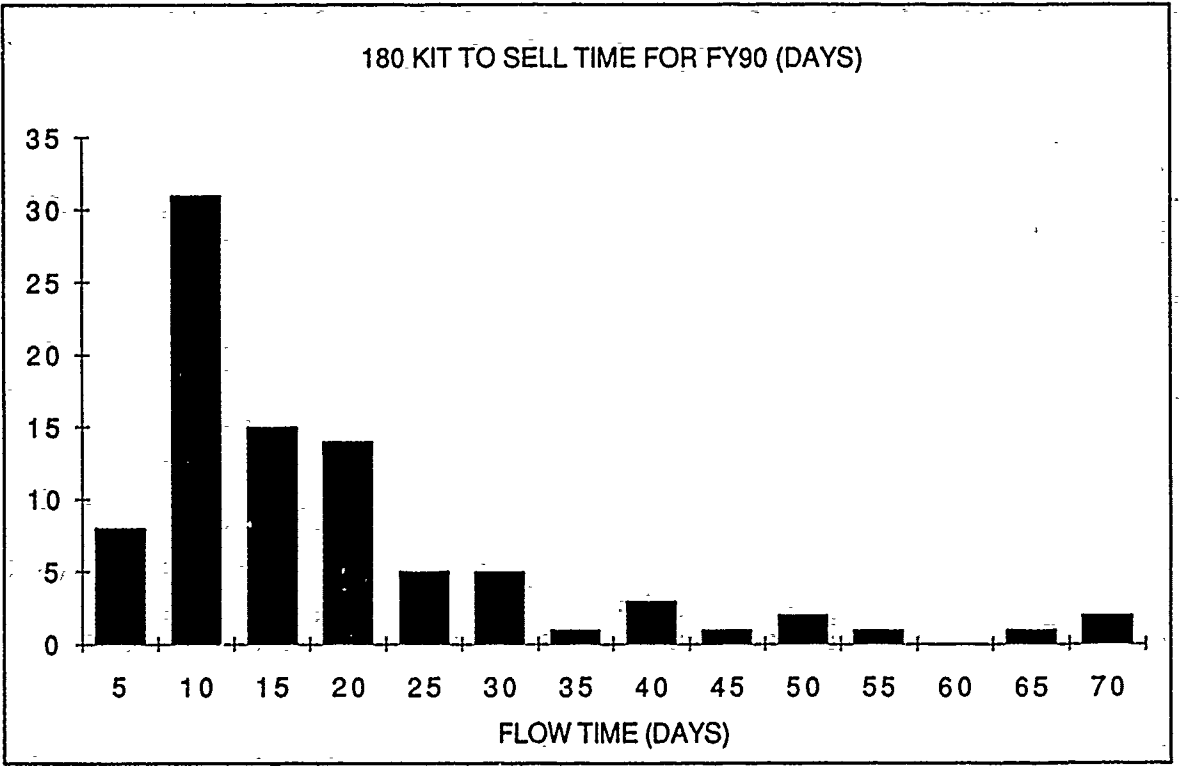
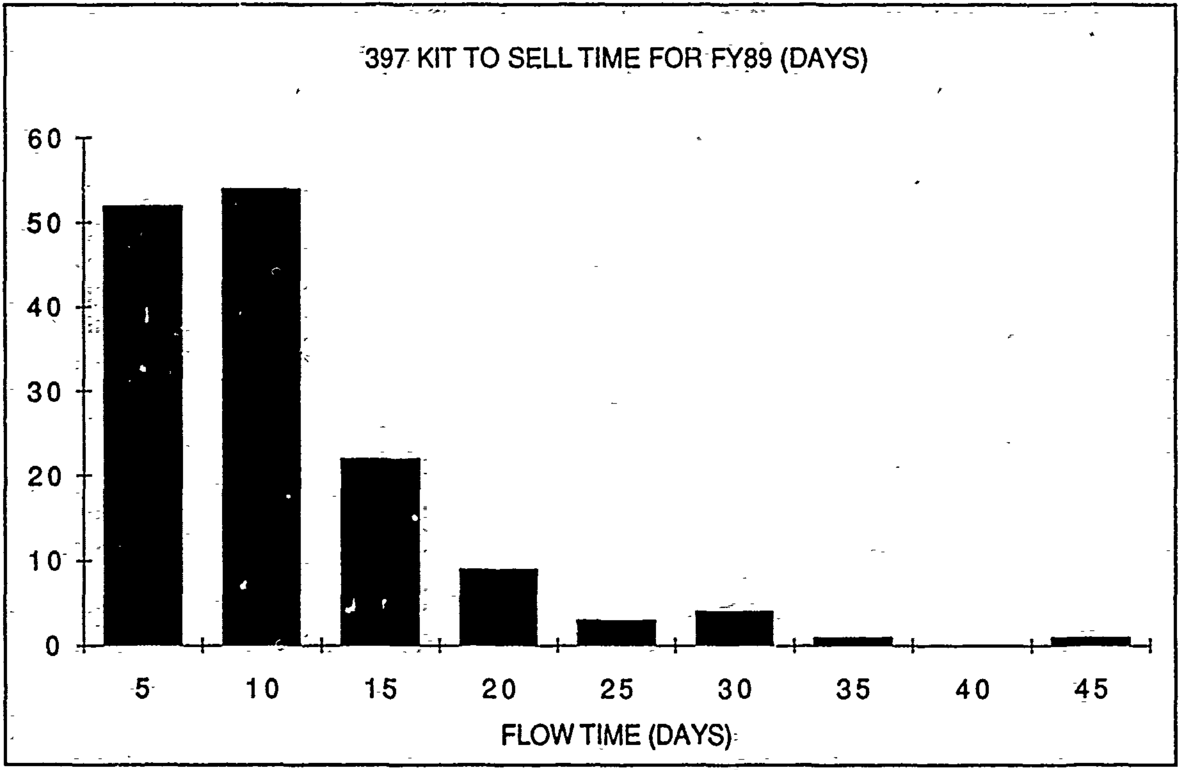
1·6

180 KTS FY 90 (CHART)



$\bar{X} = 17.08$
$s = 14.26$

397 KTS FY 89 (CHART)



$\bar{X}$ = 8.79
s = 6.69

397 KTS FY 90

	A	B	C	D
1	KIT Date	S/N	Total Time	Sold Date
2	10/20/89	P30924	0	10/20/89
3	5/23/90	P30481	1	5/24/90
4	3/14/90	P30403	2	3/16/90
5	8/20/90	P30875	2	8/22/90
6	2/26/90	P30935	2	2/28/90
7	5/2/90	P31496	2	5/4/90
8	10/2/89	P31482	3	10/5/89
9	10/2/89	P30010	4	10/6/89
10	10/2/89	P30503	4	10/6/89
11	10/24/89	P30627	4	10/28/89
12	8/15/90	P30832	4	8/19/90
13	4/9/90	P31445	4	4/13/90
14	3/12/90	P31498	4	3/16/90
15	8/11/90	P24505	5	8/16/90
16	7/24/90	P30390	5	7/31/90
17	10/23/89	P30520	5	10/28/89
18	10/14/89	P30083	6	10/25/89
19	10/18/89	P30641	6	10/24/89
20	3/13/90	P30850	6	3/19/90
21	5/24/90	P30981	6	5/30/90
22	10/5/89	P31065	6	10/17/89
23	10/20/89	P31147	6	10/26/89
24	8/20/90	P30196	7	8/27/90
25	7/24/90	P30355	7	7/31/90
26	10/24/89	P30531	7	10/31/89
27	4/3/90	P30588	7	3/10/90
28	10/23/89	P30662	7	10/30/89
29	7/24/90	P30764	7	7/31/90
30	4/11/90	P31047	7	4/18/90
31	10/24/89	P31330	7	10/31/89
32	1/2/90	P31459	7	1/9/90
33	10/5/89	P19713	8	10/13/89
34	2/20/90	P30488	8	2/28/90
35	3/12/90	P30591	8	3/20/90
36	2/20/90	P30720	8	2/28/90
37	2/20/90	P30720	8	2/28/90
38	2/26/90	P30733	8	3/6/90
39	10/17/89	P19761	9	10/26/89
40	11/21/89	P30403	9	11/30/89
41	5/21/90	P30422	9	5/30/90
42	1/2/90	P30480	9	1/11/90
43	3/7/90	P31400	9	3/16/90
44	10/2/89	P31460	9	10/11/89
45	5/22/90	P31464	9	5/31/90
46	3/1/90	P19753	10	4/11/90
47	10/3/89	P30335	10	10/13/89

	A	B	C	D
48	4/24/90	P30965	10	5/4/90
49	4/20/90	P30972	10	4/30/90
50	4/23/90	P31064	10	5/3/90
51	11/20/89	P31088	10	11/30/90
52	5/25/90	P31326	10	6/4/90
53	10/27/89	P31142	11	11/7/89
54	2/12/90	P31209	11	2/23/90
55	11/16/89	P31284	11	11/27/89
56	3/1/90	P31333	11	3/12/90
57	10/12/89	P30193	12	10/24/89
58	11/15/89	P30223	12	11/27/89
59	5/25/90	P30378	12	6/6/90
60	2/1/90	P30413	12	2/13/90
61	11/15/89	P30122	13	11/28/89
62	5/24/90	P30285	13	6/6/90
63	10/24/89	P30290	13	11/6/89
64	11/17/89	P30644	13	11/30/89
65	4/4/90	P31373	13	4/17/90
66	5/21/90	P30447	14	6/4/90
67	2/1/90	P30453	14	2/15/90
68	11/16/89	P30932	14	11/30/89
69	2/20/90	P19720	15	3/7/90
70	7/5/90	P30320	15	7/20/90
71	5/9/90	P30636	15	5/24/90
72	11/30/89	P30777	15	12/15/89
73	1/4/90	P30994	15	1/19/90
74	11/15/89	P31138	15	11/30/89
75	3/26/90	P19737	16	4/11/90
76	10/30/89	P30183	16	11/15/89
77	7/14/90	P30461	16	7/30/90
78	7/26/90	P31343	16	8/11/90
79	12/19/89	P30199	17	1/5/90
80	10/31/89	P30393	17	11/17/89
81	7/14/90	P30545	17	7/31/90
82	11/28/89	P30633	17	12/15/89
83	1/2/90	P31146	17	1/19/90
84	1/2/90	P31511	17	1/19/90
85	11/30/89	P30218	18	12/18/89
86	1/4/90	P30227	18	1/22/90
87	1/11/90	P30058	19	1/30/90
88	4/16/90	P30302	19	5/3/90
89	2/2/90	P31334	19	2/21/90
90	4/11/90	P31512	19	4/30/90
91	5/9/90	P30031	20	5/29/90
92	4/25/90	P30318	20	5/15/90
93	2/1/90	P30433	20	2/21/90
94	11/7/89	P31291	20	11/27/89

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397 KTS FY 90

	A	B	C	D
95	11/21/90	P31302	20	12/11/89
96	12/19/89	P31380	20	1/9/90
97	11/8/89	P31463	20	11/28/89
98	1/5/90	P31480	20	1/25/90
99	1/9/90	P30167	21	1/30/90
100	1/9/90	P30375	21	1/30/90
101	12/6/89	P30995	21	12/27/89
102	12/19/89	P31129	21	1/9/90
103	4/24/90	P31423	21	5/15/90
104	11/6/89	P31431	21	11/27/89
105	12/5/90	P30570	22	12/27/89
106	12/6/89	P30601	22	12/28/89
107	12/20/89	P19782	23	1/12/90
108	4/22/90	P31266	24	5/21/90
109	8/23/90	P30893	25	9/17/90
110	5/25/90	P30982	25	6/19/90
111	4/25/90	P30691	26	5/21/90
112	2/2/90	P31169	26	2/28/90
113	8/23/90	P31216	26	9/18/90
114	4/27/90	P31224	26	5/23/90
115	2/1/90	P30255	27	2/28/90
116	4/3/90	P31325	27	4/30/90
117	5/25/90	P30949	28	6/22/90
118	12/11/89	P30610	30	1/10/90
119	10/26/89	P30525	35	11/3/89
120	1/4/90	P31114	36	2/9/90
121	11/20/89	P31196	37	12/27/89
122	5/25/90	P30695	56	7/20/90
123	5/22/90	P31102	70	7/31/90
124	10/17/89	P31003	75	12/28/89

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	A	B	C	D
1	KIT Date	S/N	Total Time	Sold Date
2	10/20/89	P30924	0	10/20/89
3	5/23/90	P30481	1	5/24/90
4	3/14/90	P30403	2	3/16/90
5	8/20/90	P30875	2	8/22/90
6	2/26/90	P30935	2	2/28/90
7	5/2/90	P31496	2	5/4/90
8	10/2/89	P31482	3	10/5/89
9	10/2/89	P30010	4	10/6/89
10	10/2/89	P30503	4	10/6/89
11	10/24/89	P30627	4	10/28/89
12	8/15/90	P30832	4	8/19/90
13	4/9/90	P31445	4	4/13/90
14	3/12/90	P31498	4	3/16/90
15	8/11/90	P24505	5	8/16/90
16	7/24/90	P30390	5	7/31/90
17	10/23/89	P30520	5	10/28/89
18	10/14/89	P30083	6	10/25/89
19	10/18/89	P30641	6	10/24/89
20	3/13/90	P30850	6	3/19/90
21	5/24/90	P30981	6	5/30/90
22	10/5/89	P31065	6	10/17/89
23	10/20/89	P31147	6	10/26/89
24	8/20/90	P30196	7	8/27/90
25	7/24/90	P30355	7	7/31/90
26	10/24/89	P30531	7	10/31/89
27	4/3/90	P30588	7	3/10/90
28	10/23/89	P30662	7	10/30/89
29	7/24/90	P30764	7	7/31/90
30	4/11/90	P31047	7	4/18/90
31	10/24/89	P31330	7	10/31/89
32	1/2/90	P31459	7	1/9/90
33	10/5/89	P19713	8	10/13/89
34	2/20/90	P30488	8	2/28/90
35	3/12/90	P30591	8	3/20/90
36	2/20/90	P30720	8	2/28/90
37	2/20/90	P30720	8	2/28/90
38	2/26/90	P30733	8	3/6/90
39	10/17/89	P19761	9	10/26/89
40	11/21/89	P30403	9	11/30/89
41	5/21/90	P30422	9	5/30/90
42	1/2/90	P30480	9	1/11/90
43	3/7/90	P31400	9	3/16/90
44	10/2/89	P31460	9	10/11/89
45	5/22/90	P31464	9	5/31/90
46	3/1/90	P19753	10	4/11/90
47	10/3/89	P30335	10	10/13/89

	A	B	C	D
48	4/24/90	P30965	10	5/4/90
49	4/20/90	P30972	10	4/30/90
50	4/23/90	P31064	10	5/3/90
51	11/20/89	P31088	10	11/30/90
52	5/25/90	P31326	10	6/4/90
53	10/27/89	P31142	11	11/7/89
54	2/12/90	P31209	11	2/23/90
55	11/16/89	P31284	11	11/27/89
56	3/1/90	P31333	11	3/12/90
57	10/12/89	P30193	12	10/24/89
58	11/15/89	P30223	12	11/27/89
59	5/25/90	P30378	12	6/6/90
60	2/1/90	P30413	12	2/13/90
61	11/15/89	P30122	13	11/28/89
62	5/24/90	P30285	13	6/6/90
63	10/24/89	P30290	13	11/6/89
64	11/17/89	P30644	13	11/30/89
65	4/4/90	P31373	13	4/17/90
66	5/21/90	P30447	14	6/4/90
67	2/1/90	P30453	14	2/15/90
68	11/16/89	P30932	14	11/30/89
69	2/20/90	P19720	15	3/7/90
70	7/5/90	P30320	15	7/20/90
71	5/9/90	P30636	15	5/24/90
72	11/30/89	P30777	15	12/15/89
73	1/4/90	P30994	15	1/19/90
74	11/15/89	P31138	15	11/30/89
75	3/26/90	P19737	16	4/11/90
76	10/30/89	P30183	16	11/15/89
77	7/14/90	P30461	16	7/30/90
78	7/26/90	P31343	16	8/11/90
79	12/19/89	P30199	17	1/5/90
80	10/31/89	P30393	17	11/17/89
81	7/14/90	P30545	17	7/31/90
82	11/28/89	P30633	17	12/15/89
83	1/2/90	P31146	17	1/19/90
84	1/2/90	P31511	17	1/19/90
85	11/30/89	P30218	18	12/18/89
86	1/4/90	P30227	18	1/22/90
87	1/11/90	P30058	19	1/30/90
88	4/16/90	P30302	19	5/3/90
89	2/2/90	P31334	19	2/21/90
90	4/11/90	P31512	19	4/30/90
91	5/9/90	P30031	20	5/29/90
92	4/25/90	P30318	20	5/15/90
93	2/1/90	P30433	20	2/21/90
94	11/7/89	P31291	20	11/27/89

	A	B	C	D
95	11/21/90	P31302	20	12/11/89
96	12/19/89	P31380	20	1/9/90
97	11/8/89	P31463	20	11/28/89
98	1/5/90	P31480	20	1/25/90
99	1/9/90	P30167	21	1/30/90
100	1/9/90	P30375	21	1/30/90
101	12/6/89	P30995	21	12/27/89
102	12/19/89	P31129	21	1/9/90
103	4/24/90	P31423	21	5/15/90
104	11/6/89	P31431	21	11/27/89
105	12/5/90	P30570	22	12/27/89
106	12/6/89	P30601	22	12/28/89
107	12/20/89	P19782	23	1/12/90
108	4/22/90	P31266	24	5/21/90
109	8/23/90	P30893	25	9/17/90
110	5/25/90	P30982	25	6/19/90
111	4/25/90	P30691	26	5/21/90
112	2/2/90	P31169	26	2/28/90
113	8/23/90	P31216	26	9/18/90
114	4/27/90	P31224	26	5/23/90
115	2/1/90	P30255	27	2/28/90
116	4/3/90	P31325	27	4/30/90
117	5/25/90	P30949	28	6/22/90
118	12/11/89	P30610	30	1/10/90
119	10/26/89	P30525	35	11/3/89
120	1/4/90	P31114	36	2/9/90
121	11/20/89	P31196	37	12/27/89
122	5/25/90	P30695	56	7/20/90
123	5/22/90	P31102	70	7/31/90
124	10/17/89	P31003	75	12/28/89

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	A	B	C	D
1	KIT Date	S/N	Total Time	Sold Date
2	10/5/89	P19713	8	10/13/89
3	2/20/90	P19720	15	3/7/90
4	3/26/90	P19737	16	4/11/90
5	3/1/90	P19753	10	4/11/90
6	10/17/89	P19761	9	10/26/89
7	12/20/89	P19782	23	1/12/90
8	8/11/90	P24505	5	8/16/90
9	10/2/89	P30010	4	10/6/89
10	5/9/90	P30031	20	5/29/90
11	1/11/90	P30058	19	1/30/90
12	10/14/89	P30083	6	10/25/89
13	11/15/89	P30122	13	11/28/89
14	1/9/90	P30167	21	1/30/90
15	10/30/89	P30183	16	11/15/89
16	10/12/89	P30193	12	10/24/89
17	8/20/90	P30196	7	8/27/90
18	12/19/89	P30199	17	1/5/90
19	11/30/89	P30218	18	12/18/89
20	11/15/89	P30223	12	11/27/89
21	1/4/90	P30227	18	1/22/90
22	2/1/90	P30255	27	2/28/90
23	5/24/90	P30285	13	6/6/90
24	10/24/89	P30290	13	11/6/89
25	4/16/90	P30302	19	5/3/90
26	4/25/90	P30318	20	5/15/90
27	7/5/90	P30320	15	7/20/90
28	10/3/89	P30335	10	10/13/89
29	7/24/90	P30355	7	7/31/90
30	1/9/90	P30375	21	1/30/90
31	5/25/90	P30378	12	6/6/90
32	7/24/90	P30390	5	7/31/90
33	10/31/89	P30393	17	11/17/89
34	3/14/90	P30403	2	3/16/90
35	11/21/89	P30403	9	11/30/89
36	2/1/90	P30413	12	2/13/90
37	5/21/90	P30422	9	5/30/90
38	2/1/90	P30433	20	2/21/90
39	5/21/90	P30447	14	6/4/90
40	2/1/90	P30453	14	2/15/90
41	7/14/90	P30461	16	7/30/90
42	1/2/90	P30480	9	1/11/90
43	5/23/90	P30481	1	5/24/90
44	2/20/90	P30488	8	2/28/90
45	10/2/89	P30503	4	10/6/89
46	10/23/89	P30520	5	10/28/89
47	10/26/89	P30525	35	11/3/89

	A	B	C	D
48	10/24/89	P30531	7	10/31/89
49	7/14/90	P30545	17	7/31/90
50	12/5/90	P30570	22	12/27/89
51	4/3/90	P30588	7	3/10/90
52	3/12/90	P30591	8	3/20/90
53	12/6/89	P30601	22	12/28/89
54	12/11/89	P30610	30	1/10/90
55	10/24/89	P30627	4	10/28/89
56	11/28/89	P30633	17	12/15/89
57	5/9/90	P30636	15	5/24/90
58	10/18/89	P30641	6	10/24/89
59	11/17/89	P30644	13	11/30/89
60	10/23/89	P30662	7	10/30/89
61	4/25/90	P30691	26	5/21/90
62	5/25/90	P30695	56	7/20/90
63	2/20/90	P30720	8	2/28/90
64	2/20/90	P30720	8	2/28/90
65	2/26/90	P30733	8	3/6/90
66	7/24/90	P30764	7	7/31/90
67	11/30/89	P30777	15	12/15/89
68	8/15/90	P30832	4	8/19/90
69	3/13/90	P30850	6	3/19/90
70	8/20/90	P30875	2	8/22/90
71	8/23/90	P30893	25	9/17/90
72	10/20/89	P30924	0	10/20/89
73	11/16/89	P30932	14	11/30/89
74	2/26/90	P30935	2	2/28/90
75	5/25/90	P30949	28	6/22/90
76	4/24/90	P30965	10	5/4/90
77	4/20/90	P30972	10	4/30/90
78	5/24/90	P30981	6	5/30/90
79	5/25/90	P30982	25	6/19/90
80	1/4/90	P30994	15	1/19/90
81	12/6/89	P30995	21	12/27/89
82	10/17/89	P31003	75	12/28/89
83	4/11/90	P31047	7	4/18/90
84	4/23/90	P31064	10	5/3/90
85	10/5/89	P31065	6	10/17/89
86	11/20/89	P31088	10	11/30/90
87	5/22/90	P31102	70	7/31/90
88	1/4/90	P31114	36	2/9/90
89	12/19/89	P31129	21	1/9/90
90	11/15/89	P31138	15	11/30/89
91	10/27/89	P31142	11	11/7/89
92	1/2/90	P31146	17	1/19/90
93	10/20/89	P31147	6	10/26/89
94	2/2/90	P31169	26	2/28/90

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	A	B	C	D
95	11/20/89	P31196	37	12/27/89
96	2/12/90	P31209	11	2/23/90
97	8/23/90	P31216	26	9/18/90
98	4/27/90	P31224	26	5/23/90
99	4/22/90	P31266	24	5/21/90
100	11/16/89	P31284	11	11/27/89
101	11/7/89	P31291	20	11/27/89
102	11/21/90	P31302	20	12/11/89
103	4/3/90	P31325	27	4/30/90
104	5/25/90	P31326	10	6/4/90
105	10/24/89	P31330	7	10/31/89
106	3/1/90	P31333	11	3/12/90
107	2/2/90	P31334	19	2/21/90
108	7/26/90	P31343	16	8/11/90
109	4/4/90	P31373	13	4/17/90
110	12/19/89	P31380	20	1/9/90
111	3/7/90	P31400	9	3/16/90
112	4/24/90	P31423	21	5/15/90
113	11/6/89	P31431	21	11/27/89
114	4/9/90	P31445	4	4/13/90
115	1/2/90	P31459	7	1/9/90
116	10/2/89	P31460	9	10/11/89
117	11/8/89	P31463	20	11/28/89
118	5/22/90	P31464	9	5/31/90
119	1/5/90	P31480	20	1/25/90
120	10/2/89	P31482	3	10/5/89
121	5/2/90	P31496	2	5/4/90
122	3/12/90	P31498	4	3/16/90
123	1/2/90	P31511	17	1/19/90
124	4/11/90	P31512	19	4/30/90

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	A	B	C	D
1	KIT Date	S/N	Total Time	Sold Date
2	10/5/89	P19713	8	10/13/89
3	2/20/90	P19720	15	3/7/90
4	3/26/90	P19737	16	4/11/90
5	3/1/90	P19753	10	4/11/90
6	10/17/89	P19761	9	10/26/89
7	12/20/89	P19782	23	1/12/90
8	8/11/90	P24505	5	8/16/90
9	10/2/89	P30010	4	10/6/89
10	5/9/90	P30031	20	5/29/90
11	1/11/90	P30058	19	1/30/90
12	10/14/89	P30083	6	10/25/89
13	11/15/89	P30122	13	11/28/89
14	1/9/90	P30167	21	1/30/90
15	10/30/89	P30183	16	11/15/89
16	10/12/89	P30193	12	10/24/89
17	8/20/90	P30196	7	8/27/90
18	12/19/89	P30199	17	1/5/90
19	11/30/89	P30218	18	12/18/89
20	11/15/89	P30223	12	11/27/89
21	1/4/90	P30227	18	1/22/90
22	2/1/90	P30255	27	2/28/90
23	5/24/90	P30285	13	6/6/90
24	10/24/89	P30290	13	11/6/89
25	4/16/90	P30302	19	5/3/90
26	4/25/90	P30318	20	5/15/90
27	7/5/90	P30320	15	7/20/90
28	10/3/89	P30335	10	10/13/89
29	7/24/90	P30355	7	7/31/90
30	1/9/90	P30375	21	1/30/90
31	5/25/90	P30378	12	6/6/90
32	7/24/90	P30390	5	7/31/90
33	10/31/89	P30393	17	11/17/89
34	3/14/90	P30403	2	3/16/90
35	11/21/89	P30408	9	11/30/89
36	2/1/90	P30413	12	2/13/90
37	5/21/90	P30422	9	5/30/90
38	2/1/90	P30433	20	2/21/90
39	5/21/90	P30447	14	6/4/90
40	2/1/90	P30453	14	2/15/90
41	7/14/90	P30461	16	7/30/90
42	1/2/90	P30480	9	1/11/90
43	5/23/90	P30481	1	5/24/90
44	2/20/90	P30488	8	2/28/90
45	10/2/89	P30503	4	10/6/89
46	10/23/89	P30520	5	10/28/89
47	10/26/89	P30525	35	11/3/89

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	A	B	C	D
48	10/24/89	P30531	7	10/31/89
49	7/14/90	P30545	17	7/31/90
50	12/5/90	P30570	22	12/27/89
51	4/3/90	P30588	7	3/10/90
52	3/12/90	P30591	8	3/20/90
53	12/6/89	P30601	22	12/28/89
54	12/11/89	P30610	30	1/10/90
55	10/24/89	P30627	4	10/28/89
56	11/28/89	P30633	17	12/15/89
57	5/9/90	P30636	15	5/24/90
58	10/18/89	P30641	6	10/24/89
59	11/17/89	P30644	13	11/30/89
60	10/23/89	P30662	7	10/30/89
61	4/25/90	P30691	26	5/21/90
62	5/25/90	P30695	56	7/20/90
63	2/20/90	P30720	8	2/28/90
64	2/20/90	P30720	8	2/28/90
65	2/26/90	P30733	8	3/6/90
66	7/24/90	P30764	7	7/31/90
67	11/30/89	P30777	15	12/15/89
68	8/15/90	P30832	4	8/19/90
69	3/13/90	P30850	6	3/19/90
70	8/20/90	P30875	2	8/22/90
71	8/23/90	P30893	25	9/17/90
72	10/20/89	P30924	0	10/20/89
73	11/16/89	P30932	14	11/30/89
74	2/26/90	P30935	2	2/28/90
75	5/25/90	P30949	28	6/22/90
76	4/24/90	P30965	10	5/4/90
77	4/20/90	P30972	10	4/30/90
78	5/24/90	P30981	6	5/30/90
79	5/25/90	P30982	25	6/19/90
80	1/4/90	P30994	15	1/19/90
81	12/6/89	P30995	21	12/27/89
82	10/17/89	P31003	75	12/28/89
83	4/11/90	P31047	7	4/18/90
84	4/23/90	P31064	10	5/3/90
85	10/5/89	P31065	6	10/17/89
86	11/20/89	P31088	10	11/30/90
87	5/22/90	P31102	70	7/31/90
88	1/4/90	P31114	36	2/9/90
89	12/19/89	P31129	21	1/9/90
90	11/15/89	P31138	15	11/30/89
91	10/27/89	P31142	11	11/7/89
92	1/2/90	P31146	17	1/19/90
93	10/20/89	P31147	6	10/26/89
94	2/2/90	P31169	26	2/28/90

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	A	B	C	D
95	11/20/89	P31196	37	12/27/89
96	2/12/90	P31209	11	2/23/90
97	8/23/90	P31216	26	9/18/90
98	4/27/90	P31224	26	5/23/90
99	4/22/90	P31266	24	5/21/90
100	11/16/89	P31284	11	11/27/89
101	11/7/89	P31291	20	11/27/89
102	11/21/90	P31302	20	12/11/89
103	4/3/90	P31325	27	4/30/90
104	5/25/90	P31326	10	6/4/90
105	10/24/89	P31330	7	10/31/89
106	3/1/90	P31333	11	3/12/90
107	2/2/90	P31334	19	2/21/90
108	7/26/90	P31343	16	8/11/90
109	4/4/90	P31373	13	4/17/90
110	12/19/89	P31380	20	1/9/90
111	3/7/90	P31400	9	3/16/90
112	4/24/90	P31423	21	5/15/90
113	11/6/89	P31431	21	11/27/89
114	4/9/90	P31445	4	4/13/90
115	1/2/90	P31459	7	1/9/90
116	10/2/89	P31460	9	10/11/89
117	11/8/89	P31463	20	11/28/89
118	5/22/90	P31464	9	5/31/90
119	1/5/90	P31480	20	1/25/90
120	10/2/89	P31482	3	10/5/89
121	5/2/90	P31496	2	5/4/90
122	3/12/90	P31498	4	3/16/90
123	1/2/90	P31511	17	1/19/90
124	4/11/90	P31512	19	4/30/90

180 KTS FY 90

	A	B	C	D
1	KIT DATE	S/N	TOTAL TIME	DATE SOLD
2	11/3/89	P3934	0	11/3/89
3	4/16/90	P175	2	4/18/90
4	2/26/90	P2232	2	2/28/90
5	9/27/89	P2544	3	9/30/89
6	10/26/89	P0611	4	10/30/89
7	10/24/89	P3036	4	10/28/90
8	11/3/89	P1877	5	11/8/89
9	7/26/90	P2318	5	7/31/90
10	10/26/89	P281	5	10/31/89
11	2/8/90	P2937	6	2/14/90
12	10/24/89	P3383	6	10/30/89
13	9/20/90	P3646	6	9/26/90
14	3/20/90	P3752	6	3/26/90
15	5/2/90	P3792	6	5/8/90
16	2/21/90	P1356	7	2/28/90
17	3/9/90	P1856	7	3/16/90
18	2/21/90	P2485	7	2/28/90
19	7/24/90	P2907	7	7/31/90
20	1/23/90	P334	7	1/30/90
21	7/24/90	P3784	7	7/31/90
22	4/25/90	P0008	8	5/3/90
23	3/14/90	P124	8	3/22/90
24	2/26/90	P2502	8	3/6/90
25	7/12/90	P2838	8	7/20/90
26	3/13/90	P4316	8	3/21/90
27	1/30/90	P842	8	2/7/90
28	9/22/89	P995	8	9/30/89
29	10/19/90	P1015	9	10/28/90
30	2/14/90	P2278	9	2/23/90
31	3/13/90	P3140	9	3/22/90
32	2/14/90	P3582	9	2/23/90
33	4/25/90	P3907	9	5/4/90
34	8/20/90	P4090	9	8/29/90
35	6/27/90	P846	9	7/6/90
36	3/20/90	P1880	10	3/30/90
37	3/20/90	P2789	10	3/30/90
38	4/9/90	P3288	10	4/19/90
39	2/26/90	P3881	10	3/8/90
40	3/20/90	P978	10	3/30/90
41	4/9/90	P979	10	4/19/90
42	10/19/90	P1758	11	10/30/89
43	8/27/90	P844	11	9/7/90
44	8/9/90	PO711	11	8/20/90
45	9/14/90	P2491	12	9/26/90
46	3/14/90	P2511	12	3/26/90
47	7/5/90	P1989	13	7/18/90

	A	B	C	D
48	5/11/90	P3065	13	5/24/90
49	9/6/90	P3533	13	9/19/90
50	9/6/90	P3905	13	9/19/90
51	2/8/90	P755	13	2/21/90
52	10/2/90	P140	14	10/16/89
53	10/2/90	P2177	14	10/16/89
54	5/23/90	P3419	14	6/6/90
55	11/15/89	P2350	15	11/30/89
56	11/15/89	P905	15	11/30/89
57	5/23/90	P1500	16	6/8/90
58	4/18/90	P3371	16	5/4/90
59	2/26/90	P1287	17	3/15/90
60	11/3/89	P1889	17	11/20/89
61	7/13/90	P3743	17	7/20/90
62	5/11/90	P1979	18	5/29/90
63	8/27/90	P3379	18	9/14/90
64	8/27/90	P3655	18	9/14/90
65	1/26/90	P746	18	2/13/90
66	3/23/90	P2216	19	4/11/90
67	4/19/90	P2909	19	6/8/90
68	7/12/90	P478	19	7/31/90
69	7/26/90	P3010	20	8/15/90
70	8/9/90	P3951	20	8/19/90
71	5/25/90	P174	21	6/15/90
72	10/5/89	P3274	23	10/28/89
73	7/20/90	P0190	25	8/15/90
74	11/16/89	P335	25	12/11/90
75	5/25/90	P766	25	7/3/90
76	10/5/89	P3426	26	10/31/89
77	5/24/90	P472	26	6/19/90
78	5/30/90	P3398	27	6/26/90
79	7/26/90	P3217	28	8/23/90
80	4/9/90	P3395	28	5/7/90
81	2/1/90	P2813	33	3/6/90
82	6/27/90	P1345	37	7/3/90
83	5/25/90	P001	38	7/2/90
84	11/20/89	P1630	38	12/28/89
85	11/20/89	P1427	45	1/4/90
86	3/9/90	P4066	46	5/24/90
87	12/11/89	P2590	50	1/30/90
88	5/25/90	P3774	52	7/16/90
89	7/26/90	P558	62	9/26/90
90	3/14/90	P4221	68	5/21/90
91	11/16/89	P3255	70	1/25/90
92	11/7/89	P3057	84	1/30/90

180 KTS FY 90

	A	B	C	D
1	KIT DATE	S/N	TOTAL TIME	DATE SOLD
2	4/25/90	P0008	8	5/3/90
3	5/25/90	P001	38	7/2/90
4	7/20/90	P0190	25	8/15/90
5	10/26/89	P0611	4	10/30/89
6	10/19/90	P1015	9	10/28/90
7	3/14/90	P124	8	3/22/90
8	2/26/90	P1287	17	3/15/90
9	6/27/90	P1345	37	7/3/90
10	2/21/90	P1356	7	2/28/90
11	10/2/90	P140	14	10/16/89
12	11/20/89	P1427	45	1/4/90
13	5/23/90	P1500	16	6/8/90
14	11/20/89	P1630	38	12/28/89
15	5/25/90	P174	21	6/15/90
16	4/16/90	P175	2	4/18/90
17	10/19/90	P1758	11	10/30/89
18	3/9/90	P1856	7	3/16/90
19	11/3/89	P1877	5	11/8/89
20	3/20/90	P1880	10	3/30/90
21	11/3/89	P1889	17	11/20/89
22	5/11/90	P1979	18	5/29/90
23	7/5/90	P1989	13	7/18/90
24	10/2/90	P2177	14	10/16/89
25	3/23/90	P2216	19	4/11/90
26	2/26/90	P2232	2	2/28/90
27	2/14/90	P2278	9	2/23/90
28	7/26/90	P2318	5	7/31/90
29	11/15/89	P2350	15	11/30/89
30	2/21/90	P2485	7	2/28/90
31	9/14/90	P2491	12	9/26/90
32	2/26/90	P2502	8	3/6/90
33	3/14/90	P2511	12	3/26/90
34	9/27/89	P2544	3	9/30/89
35	12/11/89	P2590	50	1/30/90
36	3/20/90	P2789	10	3/30/90
37	10/26/89	P281	5	10/31/89
38	2/1/90	P2813	33	3/6/90
39	7/12/90	P2838	8	7/20/90
40	7/24/90	P2907	7	7/31/90
41	4/19/90	P2909	19	6/8/90
42	2/8/90	P2937	6	2/14/90
43	7/26/90	P3010	20	8/15/90
44	10/24/89	P3036	4	10/28/90
45	11/7/89	P3057	84	1/30/90
46	5/11/90	P3065	13	5/24/90
47	3/13/90	P3140	9	3/22/90

180 KTS FY 90

	A	B	C	D
48	7/26/90	P3217	28	8/23/90
49	11/16/89	P3255	70	1/25/90
50	10/5/89	P3274	23	10/28/89
51	4/9/90	P3288	10	4/19/90
52	1/23/90	P334	7	1/30/90
53	11/16/89	P335	25	12/11/90
54	4/18/90	P3371	16	5/4/90
55	8/27/90	P3379	18	9/14/90
56	10/24/89	P3383	6	10/30/89
57	4/9/90	P3395	28	5/7/90
58	5/30/90	P3398	27	6/26/90
59	5/23/90	P3419	14	6/6/90
60	10/5/89	P3426	26	10/31/89
61	9/6/90	P3533	13	9/19/90
62	2/14/90	P3582	9	2/23/90
63	9/20/90	P3646	6	9/26/90
64	8/27/90	P3655	18	9/14/90
65	7/13/90	P3743	17	7/20/90
66	3/20/90	P3752	6	3/26/90
67	5/25/90	P3774	52	7/16/90
68	7/24/90	P3784	7	7/31/90
69	5/2/90	P3792	6	5/8/90
70	2/26/90	P3881	10	3/8/90
71	9/6/90	P3905	13	9/19/90
72	4/25/90	P3907	9	5/4/90
73	11/3/89	P3934	0	11/3/89
74	8/9/90	P3951	20	8/19/90
75	3/9/90	P4066	46	5/24/90
76	8/20/90	P4090	9	8/29/90
77	3/14/90	P4221	68	5/21/90
78	3/13/90	P4316	8	3/21/90
79	5/24/90	P472	26	6/19/90
80	7/12/90	P478	19	7/31/90
81	7/26/90	P558	62	9/26/90
82	1/26/90	P746	18	2/13/90
83	2/8/90	P755	13	2/21/90
84	5/25/90	P766	25	7/3/90
85	1/30/90	P842	8	2/7/90
86	8/27/90	P844	11	9/7/90
87	6/27/90	P846	9	7/6/90
88	11/15/89	P905	15	11/30/89
89	3/20/90	P978	10	3/30/90
90	4/9/90	P979	10	4/19/90
91	9/22/89	P995	8	9/30/89
92	8/9/90	PO711	11	8/20/90

180 KTS FY 89

	A	B	C	D
1	KIT DATE	S/N	TOTAL TIME	DATE SOLD
2	3/8/89	P1005	30	4/7/89
3	8/11/89	P1036	10	8/21/89
4	10/12/88	P1048	8	10/20/88
5	7/5/89	P1335	15	7/20/89
6	9/19/89	P1339	9	9/28/89
7	11/7/88	P1345	35	12/12/88
8	12/6/88	P1378	9	12/15/88
9	12/12/88	P139	17	12/29/88
10	7/21/89	P1397	5	7/26/89
11	5/17/89	P1413	2	5/10/89
12	7/25/89	P1420	2	7/27/89
13	10/4/88	P1574	15	10/19/88
14	4/4/89	P1580	7	4/11/89
15	5/3/89	P1585	9	5/12/89
16	7/5/89	P1592	14	7/19/89
17	8/21/89	P1631	10	8/31/89
18	8/25/89	P164	6	8/31/89
19	7/18/89	P1774	7	7/25/89
20	5/12/89	P1889	4	5/16/89
21	5/3/89	P1901	6	5/9/89
22	10/12/88	P1922	20	11/1/88
23	11/2/88	P1923	13	11/15/89
24	9/7/89	P1982	11	9/18/89
25	1/25/89	P1989	7	2/1/89
26	12/14/88	P2051	13	12/27/88
27	8/1/89	P2121	7	8/8/89
28	10/18/88	P2177	56	12/12/88
29	8/21/89	P2298	2	8/23/89
30	10/20/88	P2382	51	12/9/88
31	11/10/89	P2428	12	11/22/88
32	1/26/89	P2429	15	2/10/89
33	4/10/89	P2485	22	5/2/89
34	9/19/89	P2617	9	9/28/89
35	10/24/88	P2705	7	10/31/88
36	12/1/88	P2733	13	12/14/88
37	10/18/88	P281	7	10/25/88
38	4/7/89	P2810	0	4/7/89
39	9/18/89	P2894	8	9/26/89
40	1/26/89	P2923	18	2/13/89
41	11/14/88	P2960	44	12/28/88
42	12/14/88	P2965	8	12/22/88
43	5/1/89	P30001	2	5/3/89
44	4/10/89	P3097	3	4/13/89
45	10/8/88	P3114	7	10/25/88
46	5/12/89	P3117	7	5/19/89
47	2/15/89	P3150	12	2/27/89

	A	B	C	D
48	8/30/89	P3176	1	8/31/89
49	5/8/89	P3232	9	5/17/89
50	12/19/88	P325	10	12/29/88
51	5/1/89	P3332	7	5/8/89
52	4/10/89	P3358	21	5/1/89
53	2/13/89	P3359	17	3/2/89
54	9/30/88	P3394	31	10/31/88
55	7/27/89	P347	6	8/2/89
56	10/24/88	P3517	40	12/2/88
57	3/8/89	P3523	29	4/6/89
58	8/31/89	P3583	1	9/1/89
59	4/17/89	P3585	3	4/20/89
60	7/25/89	P359	6	7/31/89
61	5/24/89	P3610	37	6/30/89
62	1/9/89	P3653	15	1/24/89
63	10/20/88	P3700	8	10/28/88
64	11/7/88	P3717	10	11/17/88
65	9/19/88	P3732	59	11/17/88
66	9/7/89	P3789	15	9/22/89
67	8/31/89	P3911	5	9/5/89
68	1/12/89	P3924	14	1/26/89
69	10/4/88	P404	15	10/19/88
70	8/25/89	P4071	3	8/28/89
71	1/5/89	P4099	7	1/12/89
72	1/5/89	P4104	27	2/1/89
73	1/3/89	P4136	2	1/5/89
74	2/23/89	P4138	6	3/1/89
75	5/1/89	P4300	4	5/5/89
76	8/30/89	P4326	1	8/31/89
77	1/9/89	P4343	8	1/17/89
78	12/20/88	P436	15	1/4/89
79	5/8/89	P487	67	7/14/89
80	12/9/88	P504	0	12/9/88
81	4/18/89	P509	15	5/3/89
82	5/17/89	P516	20	6/6/89
83	2/1/89	P522	13	2/14/89
84	9/22/89	P528	6	9/28/90
85	11/15/88	P562	0	11/15/88
86	3/2/89	P585	36	4/7/89
87	10/26/88	P606	13	11/8/88
88	1/3/89	P607	7	1/10/89
89	8/17/89	P608	14	8/25/89
90	12/12/88	P672	15	12/27/88
91	1/24/89	P766	3	1/27/89
92	10/24/88	P860	45	12/7/88
93	7/18/89	P907	3	7/21/89
94	2/2/89	P925	20	2/22/89

	A	B	C	D
95	8/28/89	P926	32	9/29/89
96	4/4/89	P958	8	4/12/89
97	8/1/89	P964	14	8/15/89
98	10/18/88	P965	3	10/21/88
99	12/7/88	P996	9	12/16/88

180 KTS FY 90

	A	B	C	D
1	KIT DATE	S/N	TOTAL TIME	DATE SOLD
2	11/3/89	P3934	0	11/3/89
3	4/16/90	P175	2	4/18/90
4	2/26/90	P2232	2	2/28/90
5	9/27/89	P2544	3	9/30/89
6	10/26/89	P0611	4	10/30/89
7	10/24/89	P3036	4	10/28/90
8	11/3/89	P1877	5	11/8/89
9	7/26/90	P2318	5	7/31/90
10	10/26/89	P281	5	10/31/89
11	2/8/90	P2937	6	2/14/90
12	10/24/89	P3383	6	10/30/89
13	9/20/90	P3646	6	9/26/90
14	3/20/90	P3752	6	3/26/90
15	5/2/90	P3792	6	5/8/90
16	2/21/90	P1356	7	2/28/90
17	3/9/90	P1856	7	3/16/90
18	2/21/90	P2485	7	2/28/90
19	7/24/90	P2907	7	7/31/90
20	1/23/90	P334	7	1/30/90
21	7/24/90	P3784	7	7/31/90
22	4/25/90	P0008	8	5/3/90
23	3/14/90	P124	8	3/22/90
24	2/26/90	P2502	8	3/6/90
25	7/12/90	P2838	8	7/20/90
26	3/13/90	P4316	8	3/21/90
27	1/30/90	P842	8	2/7/90
28	9/22/89	P995	8	9/30/89
29	10/19/90	P1015	9	10/28/90
30	2/14/90	P2278	9	2/23/90
31	3/13/90	P3140	9	3/22/90
32	2/14/90	P3582	9	2/23/90
33	4/25/90	P3907	9	5/4/90
34	8/20/90	P4090	9	8/29/90
35	6/27/90	P846	9	7/6/90
36	3/20/90	P1880	10	3/30/90
37	3/20/90	P2789	10	3/30/90
38	4/9/90	P3288	10	4/19/90
39	2/26/90	P3881	10	3/8/90
40	3/20/90	P978	10	3/30/90
41	4/9/90	P979	10	4/19/90
42	10/19/90	P1758	11	10/30/89
43	8/27/90	P844	11	9/7/90
44	8/9/90	PO711	11	8/20/90
45	9/14/90	P2497	12	9/26/90
46	3/14/90	P2511	12	3/26/90
47	7/5/90	P1989	13	7/18/90

180 KTS FY 90

	A	B	C	D
48	5/11/90	P3065	13	5/24/90
49	9/6/90	P3533	13	9/19/90
50	9/6/90	P3905	13	9/19/90
51	2/8/90	P755	13	2/21/90
52	10/2/90	P140	14	10/16/89
53	10/2/90	P2177	14	10/16/89
54	5/23/90	P3419	14	6/6/90
55	11/15/89	P2350	15	11/30/89
56	11/15/89	P905	15	11/30/89
57	5/23/90	P1500	16	6/8/90
58	4/18/90	P3371	16	5/4/90
59	2/26/90	P1287	17	3/15/90
60	11/3/89	P1889	17	11/20/89
61	7/13/90	P3743	17	7/20/90
62	5/11/90	P1979	18	5/29/90
63	8/27/90	P3379	18	9/14/90
64	8/27/90	P3655	18	9/14/90
65	1/26/90	P746	18	2/13/90
66	3/23/90	P2216	19	4/11/90
67	4/19/90	P2909	19	6/8/90
68	7/12/90	P478	19	7/31/90
69	7/26/90	P3010	20	8/15/90
70	8/9/90	P3951	20	8/19/90
71	5/25/90	P174	21	6/15/90
72	10/5/89	P3274	23	10/28/89
73	7/20/90	P0190	25	8/15/90
74	11/16/89	P335	25	12/11/90
75	5/25/90	P766	25	7/3/90
76	10/5/89	P3426	26	10/31/89
77	5/24/90	P472	26	6/19/90
78	5/30/90	P3398	27	6/26/90
79	7/26/90	P3217	28	8/23/90
80	4/9/90	P3395	28	5/7/90
81	2/1/90	P2813	33	3/6/90
82	6/27/90	P1345	37	7/3/90
83	5/25/90	P001	38	7/2/90
84	11/20/89	P1630	38	12/28/89
85	11/20/89	P1427	45	1/4/90
86	3/9/90	P4066	46	5/24/90
87	12/[illegible]/89	P2590	50	1/30/90
88	5/25/90	P3774	52	7/16/90
89	7/26/90	P558	62	9/26/90
90	3/14/90	P4221	68	5/21/90
91	11/16/89	P3255	70	1/25/90
92	11/7/89	P3057	84	1/30/90

180 KTS FY 90

	A	B	C	D
1	KIT DATE	S/N	TOTAL TIME	DATE SOLD
2	4/25/90	P0008	8	5/3/90
3	5/25/90	P001	38	7/2/90
4	7/20/90	P0190	25	8/15/90
5	10/26/89	P0611	4	10/30/89
6	10/19/90	P1015	9	10/28/90
7	3/14/90	P124	8	3/22/90
8	2/26/90	P1287	17	3/15/90
9	6/27/90	P1345	37	7/3/90
10	2/21/90	P1356	7	2/28/90
11	10/2/90	P140	14	10/16/89
12	11/20/89	P1427	45	1/4/90
13	5/23/90	P1500	16	6/8/90
14	11/20/89	P1630.	38	12/28/89
15	5/25/90	P174	21	6/15/90
16	4/16/90	P175	2	4/18/90
17	10/19/90	P1758	11	10/30/89
18	3/9/90	P1856	7	3/16/90
19	11/3/89	P1877	5	11/8/89
20	3/20/90	P1880	10	3/30/90
21	11/3/89	P1889	17	11/20/89
22	5/11/90	P1979	18	5/29/90
23	7/5/90	P1989	13	7/18/90
24	10/2/90	P2177	14	10/16/89
25	3/23/90	P2216	19	4/11/90
26	2/26/90	P2232	2	2/28/90
27	2/14/90	P2278	9	2/23/90
28	7/26/90	P2318	5	7/31/90
29	11/15/89	P2350	15	11/30/89
30	2/21/90	P2485	7	2/28/90
31	9/14/90	P2491	12	9/26/90
32	2/26/90	P2502	8	3/6/90
33	3/14/90	P2511	12	3/26/90
34	9/27/89	P2544	3	9/30/89
35	12/11/89	P2590	50	1/30/90
36	3/20/90	P2789	10	3/30/90
37	10/26/89	P281	5	10/31/89
38	2/1/90	P2813	33	3/6/90
39	7/12/90	P2838	8	7/20/90
40	7/24/90	P2907	7	7/31/90
41	4/19/90	P2909	19	6/8/90
42	2/8/90	P2937	6	2/14/90
43	7/26/90	P3010	20	8/15/90
44	10/24/89	P3036	4	10/28/90
45	11/7/89	P3057	84	1/30/90
46	5/11/90	P3065	13	5/24/90
47	3/13/90	P3140	9	3/22/90

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180 KTS FY 90

	A	B	C	D
48	7/26/90	P3217	28	8/23/90
49	11/16/89	P3255	70	1/25/90
50	10/5/89	P3274	23	10/28/89
51	4/9/90	P3288	10	4/19/90
52	1/23/90	P334	7	1/30/90
53	11/16/89	P335	25	12/11/90
54	4/18/90	P3371	16	5/4/90
55	8/27/90	P3379	18	9/14/90
56	10/24/89	P3383	6	10/30/89
57	4/9/90	P3395	28	5/7/90
58	5/30/90	P3398	27	6/26/90
59	5/23/90	P3419	14	6/6/90
60	10/5/89	P3426	26	10/31/89
61	9/6/90	P3533	13	9/19/90
62	2/14/90	P3582	9	2/23/90
63	9/20/90	P3646	6	9/26/90
64	8/27/90	P3655	18	9/14/90
65	7/13/90	P3743	17	7/20/90
66	3/20/90	P3752	6	3/26/90
67	5/25/90	P3774	52	7/16/90
68	7/24/90	P3784	7	7/31/90
69	5/2/90	P3792	6	5/8/90
70	2/26/90	P3881	10	3/8/90
71	9/6/90	P3905	13	9/19/90
72	4/25/90	P3907	9	5/4/90
73	11/3/89	P3934	0	11/3/89
74	8/9/90	P3951	20	8/19/90
75	3/9/90	P4066	46	5/24/90
76	8/20/90	P4090	9	8/29/90
77	3/14/90	P4221	68	5/21/90
78	3/13/90	P4316	8	3/21/90
79	5/24/90	P472	26	6/19/90
80	7/12/90	P478	19	7/31/90
81	7/26/90	P558	62	9/26/90
82	1/26/90	P746	18	2/13/90
83	2/8/90	P755	13	2/21/90
84	5/25/90	P766	25	7/3/90
85	1/30/90	P842	8	2/7/90
86	8/27/90	P844	11	9/7/90
87	6/27/90	P846	9	7/6/90
88	11/15/89	P905	15	11/30/89
89	3/20/90	P978	10	3/30/90
90	4/9/90	P979	10	4/19/90
91	9/22/89	P995	8	9/30/89
92	8/9/90	PO711	11	8/20/90

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Provided to MDMSC by MM item Managers.
MM POC was Ruth Agueros - 56594

MM SUPPLY DATA

Comb.Chamber Lng.
2835-01-013-4806

1) 428 on hand
2) 28% depot condemn 0% base condemn
3) $1,121.67
4) 588
5) ALT 17 months Value = 1) x 3) = $480 216
PLT 14 months
6) N/A
7) Latest demand 1984 - 145 ea.

Turbine Torus
2835-00-493-4762

1) 266 on hand
2) 0% base & depot condemn
3) $3,122.96 $830,713
4) 338
5) ALT 7 months
PLT 14 months
6) N/A
7) Latest demand 1983 - 113 ea.

GT-85-397
2835-01-242-2189

cost = $73,123
1) 374 on hand = $27,348,002
2) 323 = $23,618,729
3) Engine will not be phased out

2nd Stage Comp. Diffuser
2835-00-492-9450

1) 675 frozen for inventory
2) 1.00 condenmantion rate
3) 723.27 $486,025
4) 381 (EOQ yrs :98)
5) 11 months
6) Historical data: empty desk

Turbine Bearing Housing
2835-00-949-4581

1) 1029 on hand
2) 0% condemn
3) 1,486.37 $1,529,474
4) 18 months
5) 40 (EOQ qty)
6) Last buy was made in '86 with delivery in 1988.
7) Historically maintained quantity

Deswirl Assy
2835-00-604-4512

1) 545 on hand
2) 100%
3) 600.75
4) 77
5) ALT - 404
   PLT - 358
6) 25
7) Oct. '88, annual demand rate - 128, Oct '90 annual demand rate dropped to 34.

$327,545

2nd Stage Housing
2835-00-916-3549

1) 380 on hand
2) 21%
3) 1,156.26
4) 12
5) ALT - 339
   PLT - 436
6) 8
7) Annual demand rate is 7 ea.

$439,280

2nd Stage Diffuser
2835-00-777-1724

1) 1237 on hand
2) 38%
3) 642.62
4) 106
5) ALT - 211
   PLT - 410
6) 37
7) Sept. 88 annual demand rate was 378, May 90 annual demand rate dropped to 53.

$795,391

Wheel & Shaft Assy
2835-01-013-9906

1) 174 on hand/~~377 due in~~
2) 40%
3) 4,308.60 (includes cost of casting)
4) 367
5) ALT - 211
   PLT - 523
6) 115
7) There are 466 in condition F and repair procedures are being prototyped for these. Annual deman rate is 198.

$749,766

2nd Stage Diffuser
2835-00-492-9444

1) 494 on hand
2) 38%
3) 1,374.01
4) 342
5) ALT - 373
PLT - 471
6) 184
7) Dec. '88 Annual demand rate was 261 - June 90 annual demand had dropped to 184.

$678,756

Turbine Nozzle
2835-00-682-5364

1) 677 on hand
2) 57%
3) 2,079.18
4) 174
5) ALT - 392
PLT - 554
6) 61 ea/
7) Annual demand has decreased from 81 ea.(Nov '89) to 61 ea. (Nov 90).

$1,407,483

2nd Stage Comp. Housing
2835-00-492-9448YP

1) 200 on hand
2) 12%
3) 1,085.97
4) 84
5) ALT - 274
PLT - 408
6) 26 ea.
7) Previous demands N/A, Current demand is 45 ea.

$217,200

1st Stage Comp. Diffuser
2835-00-492-9440YP

1) 94 on hand
2) 70%
3) 1,524.04
4) 537 ea.
5) ALT - 312
PLT - 369
6) 154 ea
7) Previous demands N/A, Current demand is 36 ea.

$143 256

1st Stage Inlet Assy
2835-00-494-56-5699YP

1) 142 on hand
2) 1.00
3) 1,147.60
4) 12 months
5) 237 (EOQ yrs .93)
6) Historical data: empty desk

$163,016

Bearing Housing
2835-00-493-4763YP

1) 182 on hand
2) 3%
3) 1,529.55
4) 205
5) ALT - 7 months
PLT 14 months
6) N/A -
7) Latest average demand 1983 - 80 ea.

$278,460

G180-397
2835-01-242-8063

COST = $76,000

1) 408 on hand =$31,008,000
2) 203 in depot =$15,428,000
3) 8,906 D041 computation shown item in optimum position. Engines are not phasing out.

Accessory Case Housing
2835-00-492-9399
2835-00-759-0151

1) 15 in A/228 in M
2) 1.00
3) 2,429.73
4) 12 months
5) -0- EOQ
6) Historical data: empty desk

$590,490

Total value of
on-hand inventory
of critical items
(1) x 3)) = $9,118,696

TO 15 JIT Focus Study Cost Benefit Analysis

~~X.1.4.2~~ Potential Cost Benefit

An annual cost savings of $1,571,153 occurs from the implementation of the recommended improvements as shown in Table .

The investment cost of the recommendations is estimated at $0 . This cost includes the focus study effort and the implementation cost.

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 0% and a savings of $4,960,339 in terms of Net Present Value (NPV) using constant FY89 dollars, see Figure . The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 Mar 88.

The CBA covers the time frame starting with the focus study through 5 years after the completion of implentation. The annual cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calulated by discounting a cash flow. The focus study cost, implementation cost the recurring savings were spread by fiscal year quarters and discount back to the 1st quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in FY90 is worth $.91 in FY89 terms ($1.00 / 1.1), due to the ability to borrow or lend at a positive interest rate.

A sensivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs, see Figure .

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS
(CONSTANT FY89 DOLLARS)
TABLE (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	33	
		INVESTMENT COSTS	ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$0 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$0 (3)	$0
INSTALL & CHECKOUT	$0	$0 (4)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$0	$0
RECURRING COSTS (1)			
TOUCH LABOR	$0 (5)	$0	$60,351 (6)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$3,240,879	$0	$1,609,375
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$3,240,879	$0	$1,669,726
TOTAL COSTS	$3,240,879	$0	$1,669,726
ANNUAL COST SAVINGS	$1,571,153		

E -eA INSPECTIONS

cost of WIP

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NUMBER OF MONTHS FOR FOCUS STUDY ? 24

NUMBER OF MONTHS TO IMPLEMENT CHANGES ? 3

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS
(CONSTANT FY89 DOLLARS)
TABLE (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY EFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

PLOTTING POINTS:

CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE

	CUM	89 DISC $
FOCUS STUDY	$0	$0
IMPLEMENTATION	$0	$0
YR 1	$1,238,485	$1,238,485
YR 2	$2,364,381	$1,125,896
YR 3	$3,387,923	$1,023,542
YR 4	$4,318,415	$930,492
YR 5	$4,960,339	$641,924

CBA SENSITIVITY ANALYSIS
FIGURE

INVESTMENT	NPV	IRR	% BASELINE INVESTMENT
$0	$4,960,339	0.0%	50%
$0	$4,960,339	0.0%	75%
$0	$4,960,339	0.0%	100%
$0	$4,960,339	0.0%	125%
$0	$4,960,339	0.0%	150%
$0	$4,960,339	0.0%	175%
$0	$4,960,339	0.0%	200%

N/A
No capital Investments →

ENGINEERING NOTES

EMPLOYEE GARDNER

DATE 5 Dec 90

PAGE NO. 1

RCC MATPSI

SUBJECT INSPECTION STNDS

Standard hours "Paid" to MATPSI for GTE INSPECTION (FROM G014C Rpt)

	-180	-397
NDI	6.33 hours	5.67 hours
APIS/ DIMENSIONAL	19.91 hours	8.54 hours
TOTAL	26.24 hours	14.21 hours

DDB SECTION CODE

DDB PAGE NO. 701

ENGINEERING NOTES

EMPLOYEE GARDNER DATE 19 Sept 90 PAGE NO. 1

RCC MA SUBJECT Labor rates for Cost Savings

Susan Schattle provided the following labor rates for MA:

Burdened - $62.14/hour

unburdened - $15.80/hour

Direct mat'l - $20.64/hour

O/H Labor + G&A - $41.50/hour

These are FY 90 planning rates & were obtained from Sylvia Rodreguiz sp in MAWBE (Financial Planning)

Susan will coordinate the use of these numbers with HQ AFLC. Unless otherwise advised, MDMSC will estimate the value of labor hour reductions using the unburdened ($15.80) rate.

DDB SECTION CODE 1.0 DDB PAGE NO. ____

TO 15 SPG FOCUS STUDY COST BENEFIT ANALYSIS

~~X.1.4.2~~ Potential Cost Benefit

An annual cost savings of $1,473,262 occurs from the implementation of the recommended improvements as shown in Table .

The investment cost of the recommendations is estimated at $31,565 . This cost includes the focus study effort and the implementation cost.

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 355% and a savings of $3,727,875 in terms of Net Present Value (NPV) using constant FY89 dollars, see Figure . The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 Mar 88.

The CBA covers the time frame starting with the focus study through 5 years after the completion of implentation. The annual cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calulated by discounting a cash flow. The focus study cost, implementation cost the recurring savings were spread by fiscal year quarters and discounted back to the 1st quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in FY90 is worth $.91 in FY89 terms ($1.00 / 1.1), due to the ability to borrow or lend at a positive interest rate.

A sensivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs, see Figure .

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS
(CONSTANT FY89 DOLLARS)
TABLE (SHEET 1 OF 2)

		33	
	CURRENT ANNUAL COSTS	INVESTMENT COSTS	ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$0 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISTION	$0	$0 (3)	$0
INSTALL & CHECKOUT	$0	$0 (4)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$0	$0
RECURRING COSTS (1)			
TOUCH LABOR	$1,841,578 (5)	$31,565	$368,316 (6)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$1,841,578	$31,565	$368,316
TOTAL COSTS	$1,841,578	$31,565	$368,316
ANNUAL COST SAVINGS	$1,473,262		

NUMBER OF MONTHS FOR FOCUS STUDY ? 12

NUMBER OF MONTHS TO IMPLEMENT CHANGES ? 24

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS
(CONSTANT FY89 DOLLARS)
TABLE (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY EFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

PLOTTING POINTS:

CUM NPV IN CONSTANT FY89 DOLLARS FIGURE

	CUM	89 DISC $
FOCUS STUDY	$0	$0
IMPLEMENTATION	($42,125)	($42,125)
YR 1	$1,039,080	$1,081,205
YR 2	$2,021,993	$982,913
YR 3	$2,915,550	$893,557
YR 4	$3,727,875	$812,325
YR 5	$3,727,875	$0

CBA SENSITIVITY ANALYSIS FIGURE

INVESTMENT	NPV	IRR	% BASELINE INVESTMENT
$23,674	$3,748,938	472.4%	50%
$35,511	$3,738,407	400.4%	75%
$31,565	$3,727,875	354.9%	100%
$59,184	$3,717,344	322.5%	125%
$71,021	$3,706,813	297.9%	150%
$82,858	$3,696,282	278.2%	175%
$94,695	$3,685,751	261.9%	200%

Savings are so large
that decision is insensitive
to investment costs

INITIAL TOLERANCE/PART VARIATION

AT APIS GTE DIMENSIONAL INSPECTION

THE CHART RECOMMENDED FOR THIS PROCESS:

PRECONTROL STOPLIGHT CHART

CAUTIONS: This control charting technique is dependent on the part specification being monitored. It DOES NOT DIRECTLY MONITOR THE PROCESS, but monitors how well the process is meeting part specifications. When using this method, it is difficult to determine if the process is stable or if process improvement is occuring. However, this method gives does give direct feedback on adherance to part specifications.

To effectively use PRE-Control the CPK (process capability) of the process should be 1.33 or better.

CHART RECOMMENDED FOR THIS PROCESS:

PRECONTROL STOPLIGHT CHART

* * *

CAUTIONS: This control charting technique is dependent on the part specification being monitored. It DOES NOT DIRECTLY MONITOR THE PROCESS, but monitors how well the process is meeting part specifications. When using this method, it is difficult to determine if the process is stable or if process improvement is occuring. However, this method gives does give direct feedback on adherance to part specifications.

To effectively use PRE-Control the CPK (process capability) of the process should be 1.33 or better.

FORMULAS: UCL (RED Zone) = Above USL
LCL (RED Zone) = Below LSL

(YELLOW Zone) = (Nominal + 1/4 Tolerance) to USL
(YELLOW Zone) = (Nominal - 1/4 Tolerance) to LSL

(GREEN Zone) = Between, (Nominal + 1/4 Tolerance) and
(Nominal - 1/4 Tolerance)

Plot points = A,B

VARIABLES: A,B = the measurements of two consecutive parts
USL = Upper specification limit
LSL = Lower specification limit

RULES:

1. Check 5 consecutive pieces. If all are in the green zone, then start the production process. If any of the five are not in the green zone, then the process may not be capable. Conduct an investigation.

2. After you have 5 consecutive pieces in the green zone, take samples of 2 consecutive pieces at the prescribed intervals (see #3).

   If both pieces are in the green zone, then continue.

   If one piece is in the green zone and one is in the yellow zone, then continue.

   If both pieces are in the yellow zone, then stop production and investigate.

   If one piece is in the red zone, the stop production and investigate.

TOLERANCE VARIATION/PART AT APIS GTE DIMENSIONAL INSPECTION

THE CHART RECOMMENDED FOR THIS PROCESS:

MOVING AVERAGE AND MOVING RANGE, 3D, GROUP, CHART

CAUTIONS: Because this chart calculates ranges based on a moving average, the chart may overlook temporary fluctuations in the process. Also more judgemen is required when interpreting the chart, since the range data is dependent on the moving average and the moving average is based on measurements from different time intervals.

Also, the X (measurement) values and the variation for each process stream (machine, spindle, cavity, etc.) should be approximately equal. It is recommended that a chart be kept on each process stream until the X values and variation for each process stream is known. If they are approximately equal, then this chart may be useful.

CHART RECOMMENDED FOR THIS PROCESS:

MOVING AVERAGE AND MOVING RANGE, 3D, GROUP CHART

****

CAUTIONS: Because this chart calculates ranges based on a moving average, th chart may overlook temporary fluctuations in the process. Also more judgemen is required when interpreting the chart, since the range data is dependent on the moving average and the moving average is based on measurements from different time intervals.

Also, the X (measurement) values and the variation for each process stream (machine, spindle, cavity, etc.) should be approximately equal. It is recommended that a chart be kept on each process stream until the X values and variation for each process stream is known. If they are approximately equal, then this chart may be useful.

FORMULAS: For the Individual X chart:
UCLx = MAbar + (A2 * MRbar)
LCLx = MAbar - (A2 * MRbar)

X Plot point 1 = Max MA
X Plot point 2 = Min MA

MA = (X1 + X2 ... Xn)/n , X = Xwbar

For the part-to-part, Moving Range chart:
UCLmr = D4 * MRbar
LCLmr = 0

MR Plot point 1 = Max MR
MR Plot point 2 = Min MR

MR = (Xmax - Xmin) in the range group

For the within-the-part, R (range) chart
UCLrw = D4 * RWbar
LCLrw = 0

RW Plot point 1 = Max RW
RW Plot point 2 = Min RW

VARIABLES:
MAbar = Average value of the moving average plot points
MA = Moving average, the average of the X values for each group of (n) points
Xwbar = Average value of the part measurements
MR = Moving range, the largest X plot point minus the smallest X plot point in the range group
MRbar = Average of the MR values
RW = Maximum range of the measurements for each part.
RWbar = Average of the RW values

FACTORS:

n	A2	D4
2	1.88	3.27
3	1.02	2.57
4	0.73	2.28
5	0.58	2.11
6	0.48	2.00

of REJECTS FOUND AT NDI

THE CHART RECOMMENDED FOR THIS PROCESS:

GROUP, NP CHART

CAUTIONS: To use this chart the sample size must remain constant and the quality characteristic should be measured by counting the number of units defective. The average number of defects for each process should be greater than 2 and be approximately equal for this chart to be effective. Consideratio should be given to using separate control charts for each process in place of the "GROUP" chart.

CHART RECOMMENDED FOR THIS PROCESS:

GROUP, NP CHART

****

CAUTIONS: To use this chart the sample size must remain constant and the quality characteristic should be measured by counting the number of units defective. The average number of defects for each process should be greater than 2 and be approximately equal for this chart to be effective. Consideratio should be given to using separate control charts for each process in place of the "GROUP" chart.

```
FORMULAE:  UCL = NPbar + 3 SQR <NPbar * ( 1 - ( NPbar / n )>
           LCL = NPbar - 3 SQR <NPbar * ( 1 - ( NPbar / n )>
```

Plot point1 = max NP
Plot point2 = min NP

VARIABLES:
n = number of parts in the sample
NP = number of defective parts found for each part #
NPbar = overall average number of defective parts found

DEFECTS/PART FOUND AT NDI

THE CHART RECOMMENDED FOR THIS PROCESS:

GROUP, SHORT RUN, C CHART

CAUTIONS: To use this chart the sample size must remain constant and the quality characteristic should be measured by defects per unit. The average number of defects from each process should be greater than 2 and approximatel equal for this chart to be effective. Consideration should be given to using separate control charts for each process in place of the "GROUP" chart.

CHART RECOMMENDED FOR THIS PROCESS:

GROUP, SHORT RUN, C CHART
****
CAUTIONS: To use this chart the sample size must remain constant and the quality characteristic should be measured by defects per unit. The average number of defects from each process should be greater than 2 and approximately equal for this chart to be effective. Consideration should be given to using separate control charts for each process in place of the "GROUP" chart.

FORMULAE: UCL = +3 LCL = -3

Plot point1 = max(C - TAR Cbar) / SQR(TAR Cbar)
Plot point2 = min(C - TAR Cbar) / SQR(TAR Cbar)

VARIABLES:
C = number of defects found for each process
TAR Cbar = historical average of defects found per part

p ☐ np

ATTRIBUTES CONTROL CHART FORM

Date/Time									
Sample Size									
Number (np,c)									
Fraction (p,u)									
Notes									

PARTS AVG

A ______ ______
B ______ ______
C ______ ______
D ______ ______
E ______ ______
F ______ ______
G ______ ______
H ______ ______
J ______ ______

TYPE OF DEFECTS									

1 of 2

714

p ☐ c ☐ u ☐

2072

3-D CONTROL CHARTS

TARGETS

PART	X	R
A		
B		
C		
D		
E		
F		
H		
J		

DATE									
TIME									
PART									
X									
(X-Xt)									
(X-Xt)/Rpt									
Rp									
Rp/Rpt									
Rw									
Rw/Rwt									

UCLX = ____________

CL = ____________

LCLX = ____________

Rp

UCLX = ____________

CL = ____________

LCLX = ____________

Rw

UCLX = ____________

CL = ____________

LCLX = ____________

182 715

X BAR AND R,S CHART

DATE										
TIME										
PART										
PIECES	1									
	2									
	3									
	4									
	5									
TOTAL X										
AVERAGE X										
TARGET X										
(X - TAR X)										
TARGET R										
(X - X) / R										
RANGE R										
R/TAR R										

TARGETS

PART		X	R
A			
B			
C			
D			
E			
F			
G			
H			
J			

UCLX = ____________

CL = ____________

LCLX = ____________

R,S

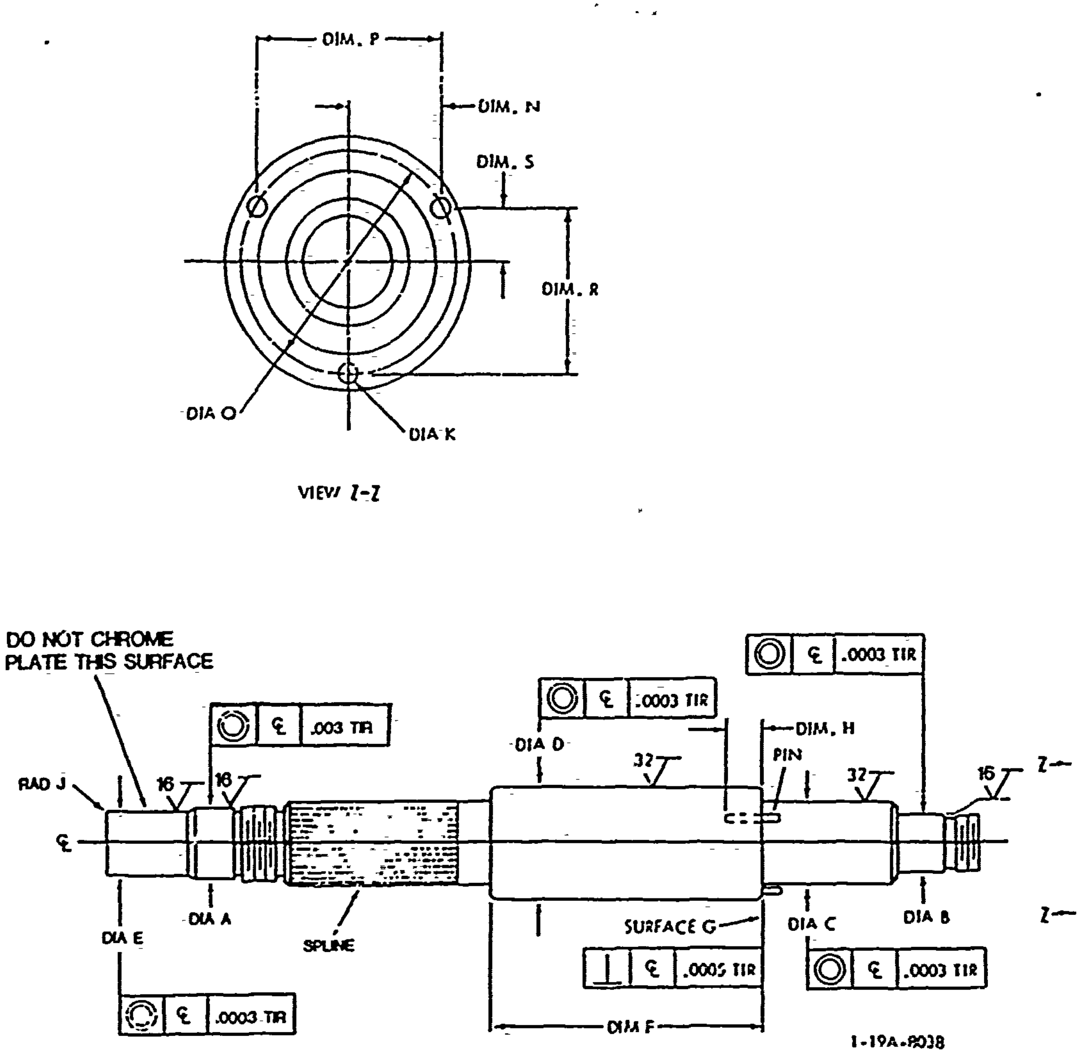
UCLR = ____________

CENTER LINE = ____________

LCLR = ____________

1of5

2 of 2



DIA A	0.8695 to 0.8700 inch	RAD J	0.010 to 0.020 inch
DIA B	0.7872 to 0.7876 inch	DIA K	0.094 to 0.096 inch
DIA C	1.1570 tp 1.1574 inches	DIM. N	0.590 to 0.600 inch
DIA D	1.624 to 1.625 inches	DIM. P	1.186 to 1 196 inches
DIA E	0.8669 to 0.8674 inch	DIA Q	1.375 inches basic
DIM. F	3.750 inches minimum	DIM. R	1.027 to 1.037 inches
DIM. H	0.23 to 0.26 inch	DIM. S	0.339 to 0,349 inch

Figure 1. Compressor Shaft Assembly (Shaft Assembly) - Repair

b. Repair Diameters A through E by Chrome Plating or Plasma Spraying.

NOTE

- Remove only the minimum amount of base metal to establish shaft centerline concentric within 0.0002, total indicator reading, to diameters A and B.
- Rework of diameter E can only be done by plasma spray.
- Previous chrome plate or plasma spray must be removed to achieve proper repair. Chrome plating may be chemically removed.
- Remove only the minimum amount of base metal to clean up damage and remove old chrome plate or plasma spray.
- Pre-grind all dimensions 0.050 to 0.070 inch from shoulders.

(1) Repair diameter A by chrome plating.

NOTE

If damage is not removed by machining, grinding or chemically stripping diameter A to 0.857 inch minimum, plasma spray must be used.

(a) Machine, grind or chemically strip diameter A, not to exceed 0.857 inch minimum.

(b) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(c) Shot peen area to be chrome plated in accordance with MIL-S-13165 using steel shot (53-101).

(d) Chrome plate surface in accordance with QQ-C-320, Type I to a minimum diameter of 0.880 inch.

(e) Final machine or grind diameter A maintaining specified limits. Break edges of diameter A.

(f) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(g) Apply corrcsion preventative compound (53-31A) to reworked area.

(h) Balance in accordance with step c.

7/8

(2) Repair in diameter A by plasma spraying.

  (a) Machine or grind diameter A, not to exceed 0.839 inch minimum.

  (b) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

  (c) Plasma spray in accordance with T.O. 2-1-111 using metal spray (53-100) or equivalent to a minimum diameter of 0.880 inch.

  (d) Final machine or grind diameter A maintaining specified limits. Break edges of diameter A.

  (e) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

  (f) Apply corrosion preventative compound (53-31A) to reworked area.

  (g) Balance in accordance with step c.

(3) Repair diameter B by chrome plating.

  (a) Machine, grind or chemically strip diameter B, not to exceed 0.775 inch minimum.

    1 If damage is not removed by machining, grinding or chemically stripping diameter B to 0.775 inch minimum, plasma spray must be used.

  (b) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

  (c) Shot peen area to be chrome plated in accordance with MIL-S-13165 using steel shot (53-101).

  (d) Chrome plate surface in accordance with QQ-C-320, Type I to a minimum diameter of 0.797 inch.

  (e) Final machine or grind diameter B maintaining specified limits. Break edges of diameter B.

  (f) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

  (g) Apply corrosion preventative compound (53-31A) to reworked area.

  (h) Balance in accordance with step c.

(4) Repair diameter B by plasma spraying.

  (a) Machine or grind diameter B, not to exceed 0.757 inch minimum.

  (b) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

  (c) Plasma spray in accordance with T.O. 2-1-111 using metal spray (53-100) or equivalent to a minimum diameter of 0.797 inch.

  (d) Final machine or grind diameter B maintaining specified limits. Break edges of diameter B.

  (e) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

  (f) Apply corrosion preventative compound (53-31A) to reworked area.

  (g) Balance in accordance with step c.

719

(5) Repair diameter C by chrome plating.

(a) Remove three pins in accordance with step a(1).

NOTE

If damage is not removed by machining, grinding or chemically stripping diameter C to 1.145 inch minimum, plasma spray must be used.

(b) Machine, grind or chemically strip diameter C, not to exceed 1.145 inches minimum.

(c) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(d) Shot peen area to be chrome plated in accordance with MIL-S-13165 using steel shot (53-101).

(e) Chrome plate surface in accordance with QQ-C-320, Type I to a minimum diameter of 1.167 inches.

(f) Final machine or grind diameter C maintaining specified limits. Break edges of diameter C.

(g) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(h) Apply corrosion preventative compound (53-31A) to reworked area.

(i) Replace three pins in accordance with steps a(2) through (5).

(j) Balance in accordance with step c.

(6) Repair diameter C by plasma spraying.

(a) Remove three pins in accordance with step a(1).

(b) Machine, grind or chemically strip diameter C, not to exceed 1.127 inches minimum.

(c) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(d) Plasma spray in accordance with T.O. 2-1-111 using metal spray (53-100) or equivalent to a minimum diameter of 1.167 inches.

(e) Final machine or grind diameter C maintaining specified limits. Break edges of diameter C.

(f) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(g) Apply corrosion preventative compound (53-31A) to reworked area.

(h) Replace three pins in accordance with step a(2) through (5).

(i) Balance in accordance with step c.

720

(7) Repair diameter D by chrome plating.

   (a) Machine, grind or chemically strip diameter D, not to exceed 1.612 inches minimum.

      1 If damage is not removed by machining, grinding or chemically stripping diameter D to 1.612 inches minimum, plasma spray must be used.

   (b) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

   (c) Shot peen area to be chrome plated in accordance with MIL-S-13165 using steel shot (53-101).

   (d) Chrome plate surface in accordance with QQ-C-320. Type I to a minimum diameter of 1.635 inches.

   (e) Final machine or grind diameter D maintaining specified limits. Break edges of diameter D.

   (f) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

   (g) Apply corrosion preventative compound (53-31A) to reworked area.

   (h) Balance in accordance with step c.

(8) Repair diameter D by plasma spraying.

   (a) Machine, grind diameter D, not to exceed 1.595 inches minimum.

   (b) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

   (c) Plasma spray in accordance with T.O. 2-1-111 using metal spray (53-100) or equivalent to a minimum diameter of 1.635 inches.

   (d) Final machine or grind diameter D maintaining specified limits. Break edges of diameter D.

   (e) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

   (f) Apply corrosion preventative compound (53-31A) to reworked area.

   (g) Balance in accordance with step c.

(9) Repair diameter E by plasma spraying. (Do not chrome plate diameter E.)

   (a) Machine, grind diameter E, not to exceed 0.837 inch minimum.

   (b) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

   (c) Plasma spray in accordance with T.O. 2-1-111 using metal spray (53-100) or equivalent to a minimum diameter of 0.877 inch.

   (d) Final machine or grind diameter E maintaining specified limits.

   (e) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

   (f) Apply corrosion preventative compound (53-31A) to reworked area.

   (g) Balance in accordance with step c.

721

c. Balance Compressor Shaft Assembly. (See figure 2.)

NOTE

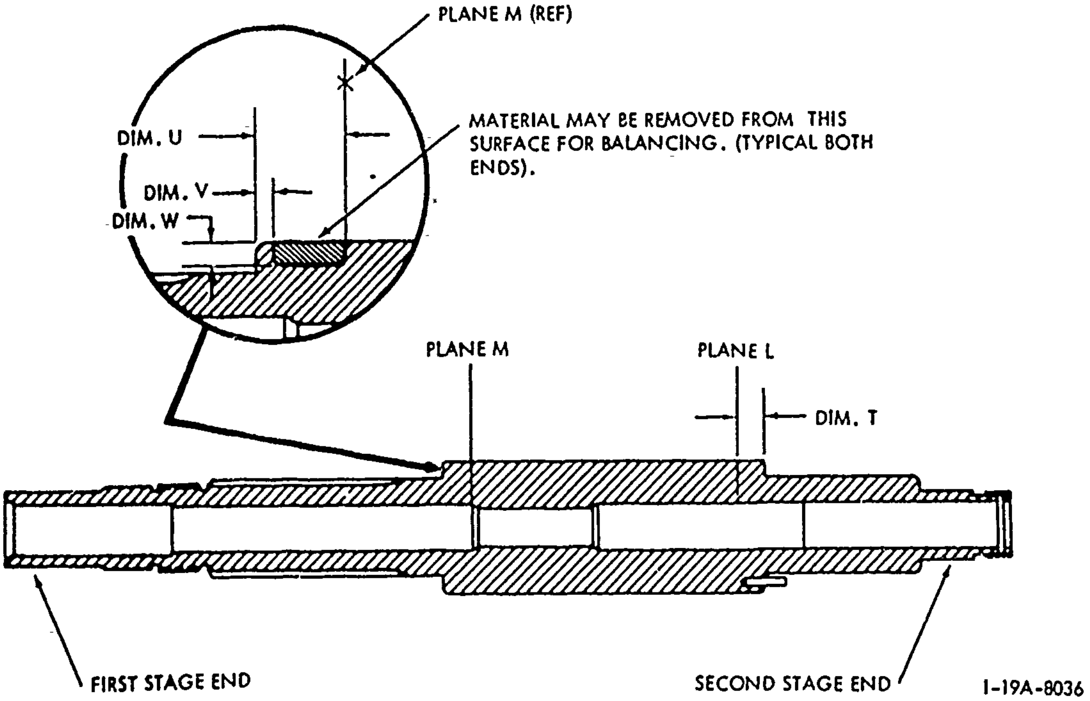
Tools called out in the following procedure are for use on a standard 1S or 13S Gisholt balancing machine.

(1) Balance in accordance with WP 003 00, paragraph 7s. Shaft P/N 371690-10 can be balanced as a rotating group IAW T.O. 2G-GTCP85-53-8, WP 003 00.

(2) Using 256377-3 insert to support first stage end of shaft assembly and 256377-11 insert to support second stage end of shaft assembly, secure shaft assembly to balance machine.

(3) Balance shall be accurate within 0.0050 ounce-inch in planes L and M.

(4) Material may be removed from areas within specified limits to obtain balance.



DIM. T	0.750 inch maximum	DIM. V	0.062 inch maximum
DIM. U	0.750 inch maximum	DIM. W	0.098 inch maximum

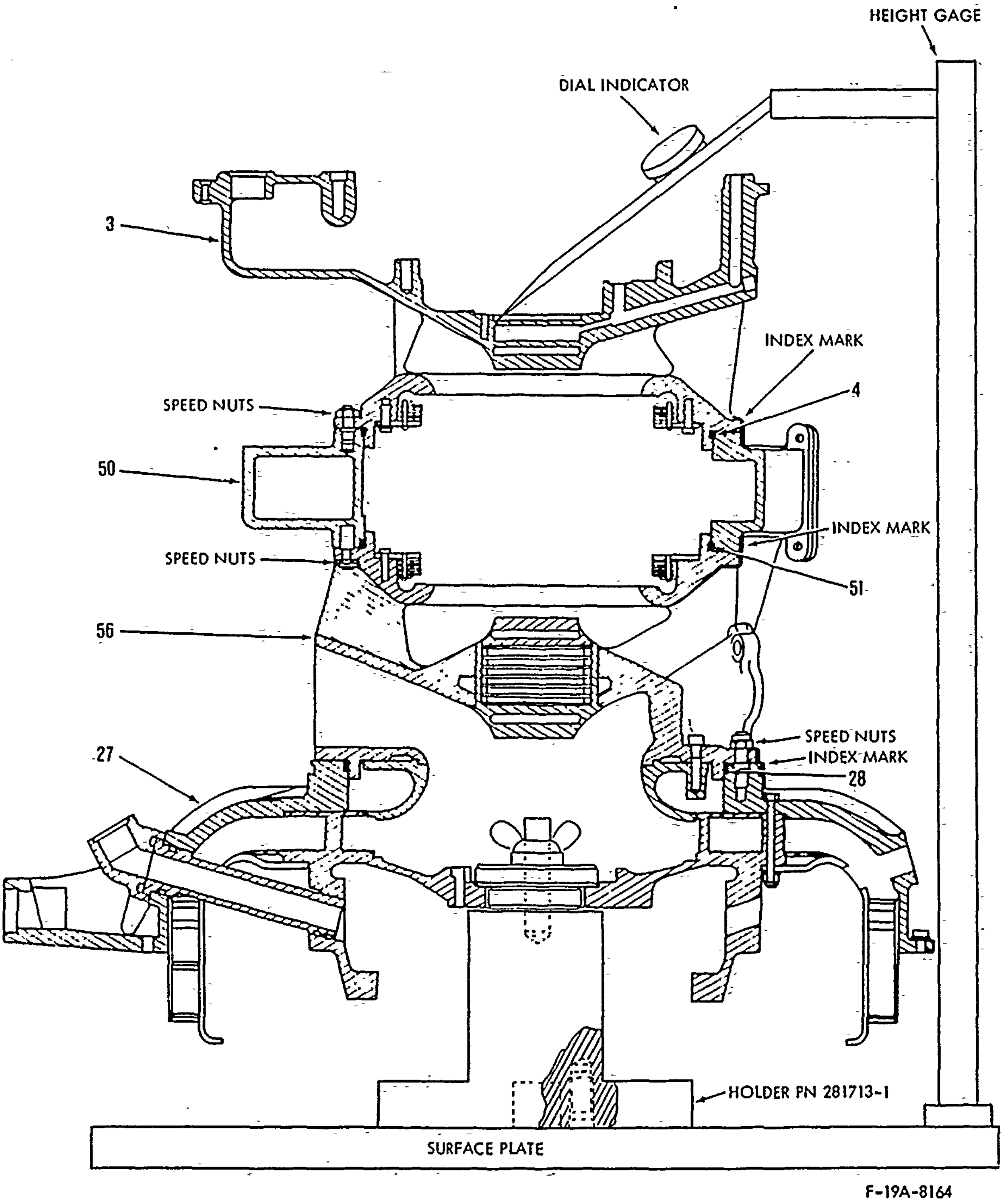
Figure 2. Compressor Shaft Assembly (Shaft Assembly) - Balancing

(5) Apply corrosion preventative compound (53-31A) to reworked area.

(6) Tag shaft assembly as BALANCED and package in accordance with MIL-P-116 to prevent damage.

371690

722



3.	Compressor inlet assembly	50.	First stage compressor diffuser assembly
4.	Packing	51.	Packing
27.	Second stage diffuser housing assembly	56.	Second stage compressor housing assembly
28.	Packing		

Figure 4. Compressor Components Bore Alignment and Check Concentricity

723

d. Compressor Components Bore Alignment.

(1) Temporarily install second stage diffuser housing assembly (27, figure 4) on 281713-1 holder assembly with bearing bore of housing assembly fitting on stepped shoulder of holder assembly.

(2) Attach holder plate and tighten holder nut to remove excess end play. Second stage diffuser housing assembly (27) shall be free to rotate.

(3) Install packing (28) and second stage compressor housing assembly (56) on second stage diffuser housing assembly (27) and secure with washers and speed nuts. Tighten speed nuts and torque to 20 to 25 inch-pounds.

NOTE

> Each housing or diffuser may be installed individually and runout accomplished at each pilot diameter or assembled and runout accomplished in accordance with steps e.(1) through (7). Runout at each bore assembled separately shall not exceed 0.004 inch.

(4) Install first stage compressor diffuser assembly (50) and packing (51) on second stage compressor housing assembly (56) with flats aligned and secure with washers and speed nuts. Tighten speed nuts and torque to 20 to 25 inch-pounds.

(5) Align oil hole in compressor inlet assembly (3) with oil drain hole in second stage diffuser housing assembly (27).

(6) Install compressor inlet assembly (3) and packing (4) on first stage compressor diffuser assembly (50) and secure with washers and speed nuts. Tighten speed nuts and torque to 20 to 25 inch-pounds.

e. Check Concentricity of Components Bore.

(1) Place a height gage on a flat surface plate and use a dial indicator to check concentricity of bearing bore in compressor inlet assembly (3, figure 4).

(2) Concentricity shall be within 0.006 inch total indicator reading.

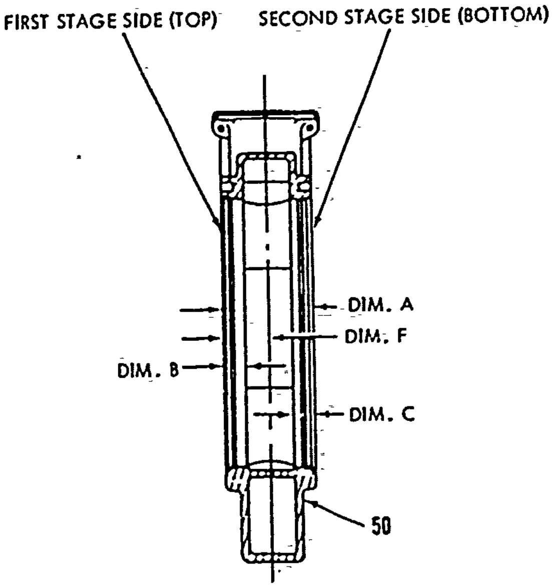
(3) If concentricity cannot be obtained, remove attaching washers and speed nuts and rotate first stage compressor diffuser assembly (50, figure 4 continued) or second stage compressor housing assembly (56) on second stage diffuser housing assembly (27) to attain best possible concentricity.

(4) When satisfactory alignment has been obtained, index mark all components with industrial marking ink (53-52) for reference at final assembly.

(5) Remove height gage and dial indicator.

(6) Remove washers and speed nuts and separate stackup. Keep all components together as a matched set.

(7) Remove second stage diffuser housing assembly (27) from 281713-1 holder assembly.



1-19A-8423

50. First stage compressor diffuser assembly

Figure 5. First Stage Compressor Diffuser Assembly Measurements

726

f. First Stage Compressor Diffuser Assembly Measurements.

NOTE

If dimension F has been determined previously, proceed to step g.

(1) Measure thickness of first stage compressor diffuser assembly (50, figure 5) between mounting flange surfaces [redacted]es. Record maximum thickness as dimension A.

(2) Measure thickness of mounting flange on first stage side (top) of first stage compressor diffuser assembly (50) [redacted] Record maximum thickness as dimension B.

(3) Subtract dimension B from dimension A. Record as dimension D.

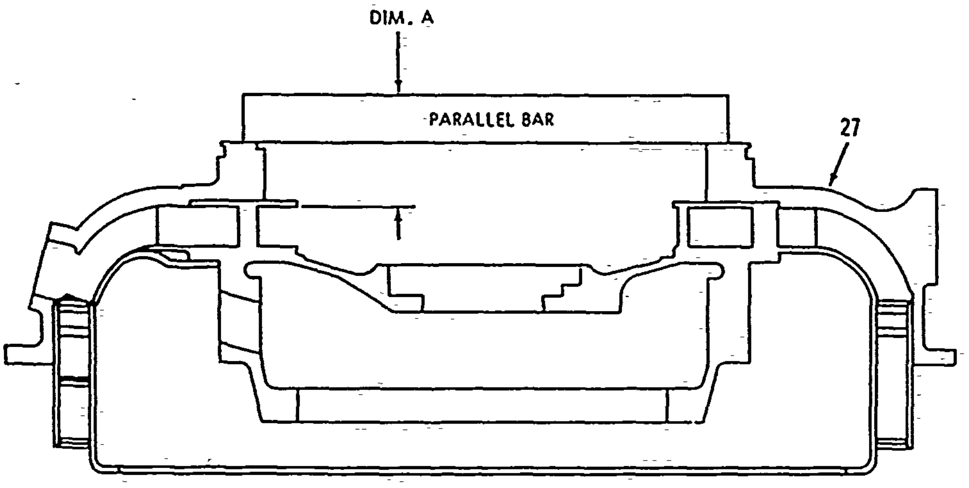
(4) Measure thickness of mounting flange on second stage side (bottom) of first stage compressor diffuser assembly (50) a[redacted]s. Record maximum thickness as dimension C.

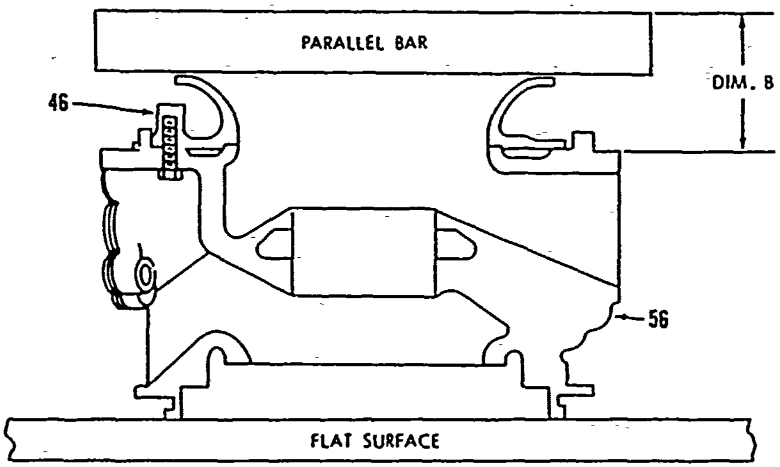
(5) Subtract dimension C from dimension D. Record as dimension E.

(6) Divide dimension E by two and add dimension B. Record as dimension F.

Formula: $A - B = D$
$D - C = E$
$E \div 2 + B = F$

(7) Retain dimension F for later use.





F-19A-7277

27. Second stage diffuser housing assembly
46. Second stage impeller shroud assembly
56. Second stage compressor housing assembly

Figure 6. Determine Thickness of Shims Required to Align Second Stage Impeller Shroud Assembly and Second Stage Diffuser Housing Assembly

728

g. Determine Thickness of Shims Required to Align Second Stage Impeller Shroud Assembly and Second Stage Diffuser Housing Assembly.

(1) Obtain a parallel bar of known thickness for use in steps (2) and (7).

(2) Place parallel bar on flange of second stage diffuser housing assembly (27, figure 6).

(3) Using a micrometer, measure depth of second stage diffuser housing assembly (27) at t[redacted] to top of parallel bar.

(4) Using a micrometer, measure the thickness of plate at [redacted] and add maximum dimension to measurement of step (3).

(5) Record highest reading as dimension A. Dimension A shall include thickness of parallel bar.

(6) Temporarily assemble second stage compressor housing assembly (56) and second stage impeller shroud assembly (46) and place on a flat surface with second stage compressor housing assembly (56) downward.

(7) Place parallel bar across second stage impeller shroud assembly (46).

(8) Measure distance from parallel bar to smooth flange of second stage compressor housing assembly (56) at [redacted].

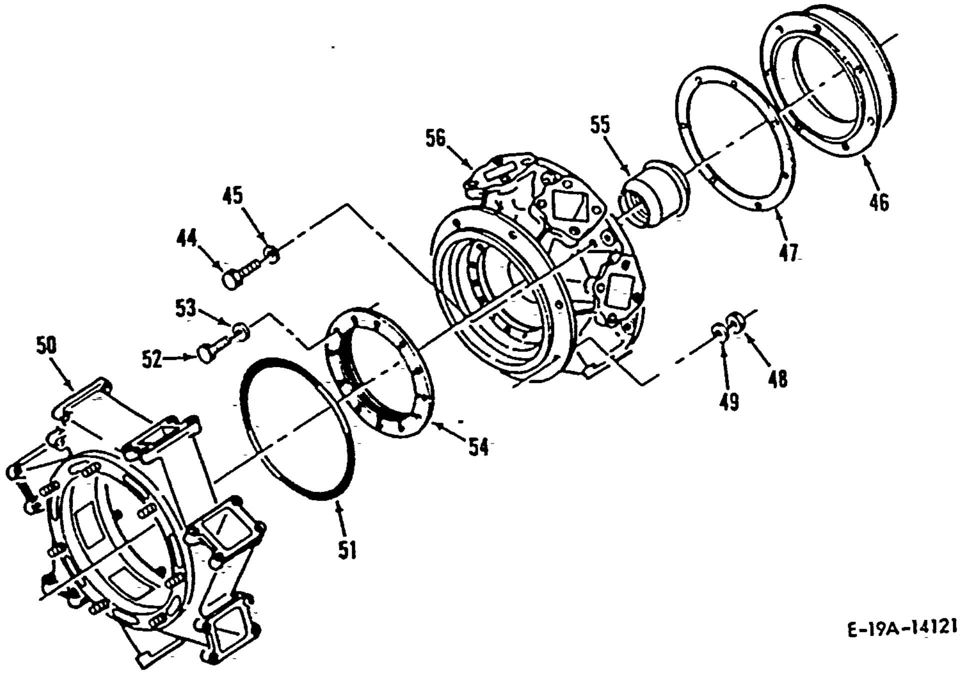
(9) Record lowest reading as dimension B. Dimension B shall include thickness of parallel bar.

(10) Subtract dimension B from dimension A and add 0.005 inch. Result is thickness of shims required between second stage impeller shroud assembly (46) and second stage compressor housing assembly (56).

[redacted]

(11) Place an alignment mark on second stage impeller shroud assembly (46, figure 6) and second stage compressor housing assembly (56) using industrial marking ink (53-52).

(12) Remove second stage impeller shroud assembly (46) from second stage compressor housing assembly (56).



44. Screw
45. Washer
46. Second stage impeller shroud assembly
47. Second stage shroud shim
48. Nut
49. Washer
50. First stage compressor diffuser assembly
51. Packing
52. Screw
53. Washer
54. First stage impeller seal assembly
55. Interstage seal assembly
56. Second stage compressor housing assembly

Figure 7. Install Second Stage Impeller Shroud, Second Stage Compressor Housing and First Stage Compressor Diffuser Assemblies

9. ASSEMBLY.

a. Install Second Stage Impeller Shroud, Second Stage Compressor Housing and First Stage Compressor Diffuser Assemblies.

NOTE

Ensure that high metal has been removed from second stage shroud shims (47, figure 7). Use guide pins when installing second stage shroud shims (47).

(1) Install guide pins in second stage compressor housing assembly. Install thickness of second stage shroud shim (47) determined in paragraph 8.g.(10) and second stage impeller shroud assembly (46) on second stage compressor housing assembly (56).

(2) Install bolt in helicoil until locking device is contacted. Using a standard torque wrench, measure frictional torque prior to installing screws (44).

NOTE

Allow 2 to 4 hours cure time to sealing compound (53-39) at room temperature prior to running engine.

(3) Apply sealing compound (53-39) to threads of screws (44).

(4) Install screws (44) and washers (45).

(5) Tighten screws (44) and torque to 20 to 25 inch-pounds plus frictional torque.

(6) Recheck measurement at dimension B, figure 6. Subtract dimension A from dimension B. Result shall be 0.000 to +0.005 inch. Adjust second stage shroud shims (47, figure 7), if necessary.

WARNING

Dry ice is solid CO2 that has a temperature well below zero C (-80°C). Skin contact with dry ice will cause serious low temperature burns. Temperature resistant gloves and apron shall be used when handling. Carbon dioxide displaces oxygen, which can cause asphyxiation. Use only in a well-ventilated area.

(7) Place interstage seal assembly (55) in dry ice (53-43) for 10 minutes.

(8) Press interstage seal assembly (55, figure 7 continued) into second stage compressor housing assembly (56).

(9) Install bolt in helicoil until locking device is contacted. Using a standard torque wrench, measure frictional torque prior to installing screws (52).

NOTE

> Allow 2 to 4 hours cure time to sealing compound (53-39) at room temperature prior to running engine.

(10) Apply sealing compound (53-39) to threads of screws (52).

(11) Install first stage impeller seal assembly (54) and secure with screws (52) and washers (53).

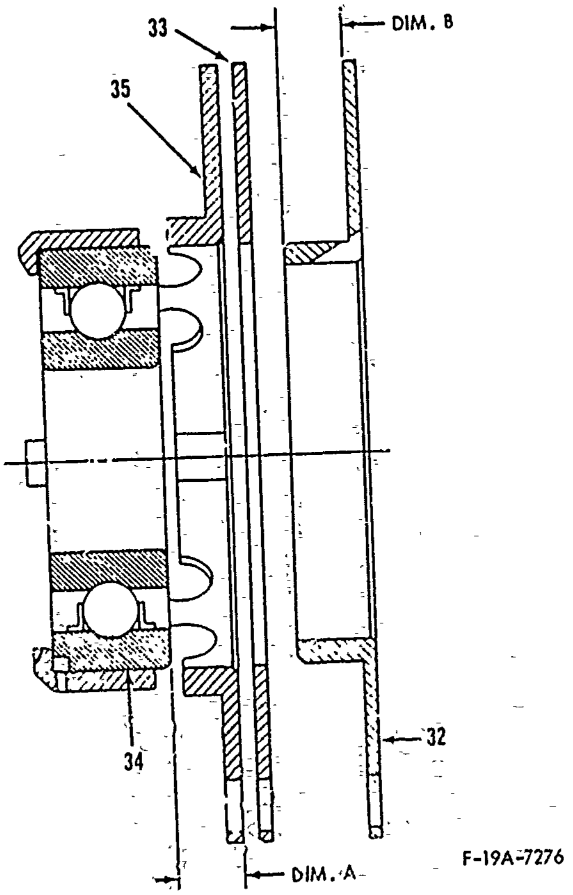
(12) Tighten screws (52) and torque to 25 to 30 inch-pounds plus frictional torque.

(13) Install packing (51) in groove of second stage compressor housing assembly (56).

(14) Install first stage compressor diffuser assembly (50) on second stage compressor housing assembly (56) aligning index marks.

(15) Secure with nuts (48) and washers (49).

(16) Tighten nuts (48) and torque to 20 to 25 inch-pounds.



32. Compressor bearing retainer	34. Bearing
33. Compressor bearing shim	35. Bearing mount assembly

Figure 8. Determine Thickness of Shims Required to Obtain 0.002 to 0.005 Inch Gap Between Bearing and Compressor Bearing Retainer

b. Determine Thickness of Shims Required to Obtain 0.002 to 0.005 Inch Gap Between Bearing and Compressor Bearing Retainer.

CAUTION

> Use clean lint-free gloves when handling jet engine anti-friction bearings to prevent damage to bearing surfaces from fingerprints.

NOTE

> Ensure slot in bearing (34, figure 8) is aligned with pin in bearing mount assembly (35) when installed.

(1) Install bearing (34) into bearing mount assembly (35).

(2) Measure from face of bearing (34) to mounting surface of bearing mount assembly (35). Record as dimension A.

(3) Measure from mounting surface flange of compressor bearing retainer (32) to edge (lip) of compressor bearing retainer (32). Record as dimension B.

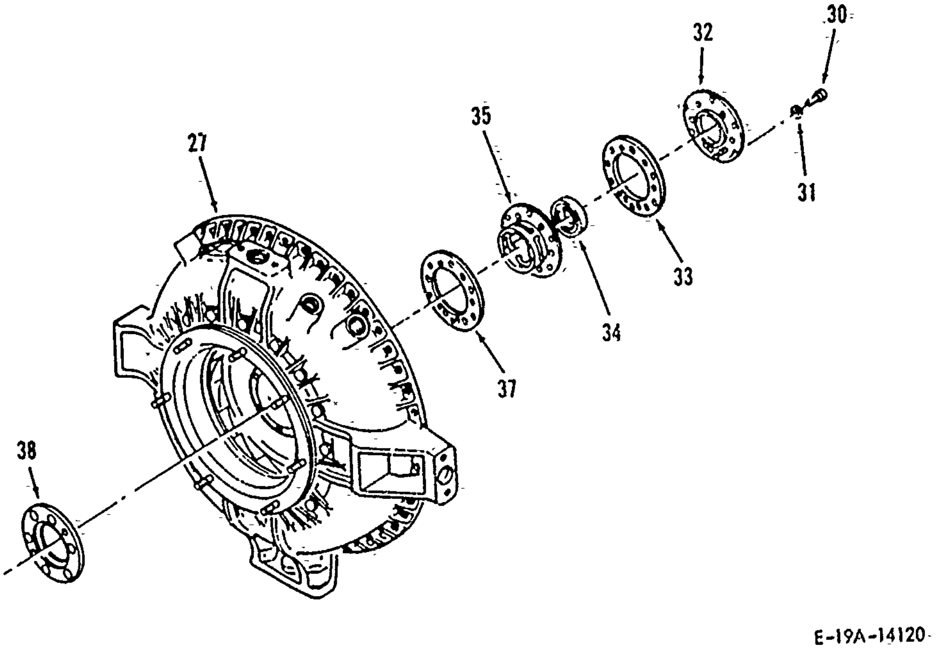
NOTE

> If 0.001 to 0.003 inch clearance cannot be obtained, replace parts as required to obtain proper clearance.

(4) Subtract dimension A from dimension B. If difference is between 0.001 and 0.003 inch, compressor bearing shims (33) are not required.

Formula: $B - A + 0.002$ inch = Compressor bearing shims (33) ±0.001 inch

(5) Select required thickness of compressor bearing shims (33).



27. Second stage diffuser housing assembly
30. Externally relieved bolt
31. Washer
32. Compressor bearing retainer
33. Compressor bearing shim
34. Bearing
35. Bearing mount assembly
37. Compressor bearing shim
38. Compressor seal assembly

Figure 9. Install Compressor Seal Assembly

c. Install Compressor Seal Assembly.

(1) Install 0.062 inch trial thickness of compressor bearing shim (37, figure 9) in place on second stage diffuser housing assembly (27).

CAUTION

Use clean lint-free gloves when handling jet engine anti-friction bearings to prevent damage to bearing surfaces from fingerprints.

(2) Install assembled bearing (34) and bearing mount assembly (35) in second stage diffuser housing assembly (27) making sure all holes are aligned.

(3) Install compressor bearing shims (33) if required and compressor bearing retainer (32) in bearing mount assembly (35).

NOTE

When installing dummy stator portion of compressor seal assembly (38), ensure chamfer edge is toward second stage diffuser housing assembly.

(4) Install dummy stator portion of compressor seal assembly (38) on forward side of second stage diffuser housing assembly (27).

(5) Secure with six externally relieved bolts (30) and washers (31). Tighten externally relieved bolts (30) and torque to 20 to 30 inch-pounds.

CAUTION

Use clean lint-free gloves when handling jet engine carbon seals to prevent damage to seal surfaces from fingerprints.

(6) Install rotor portion of compressor seal assembly (38) with flat face upward.

735

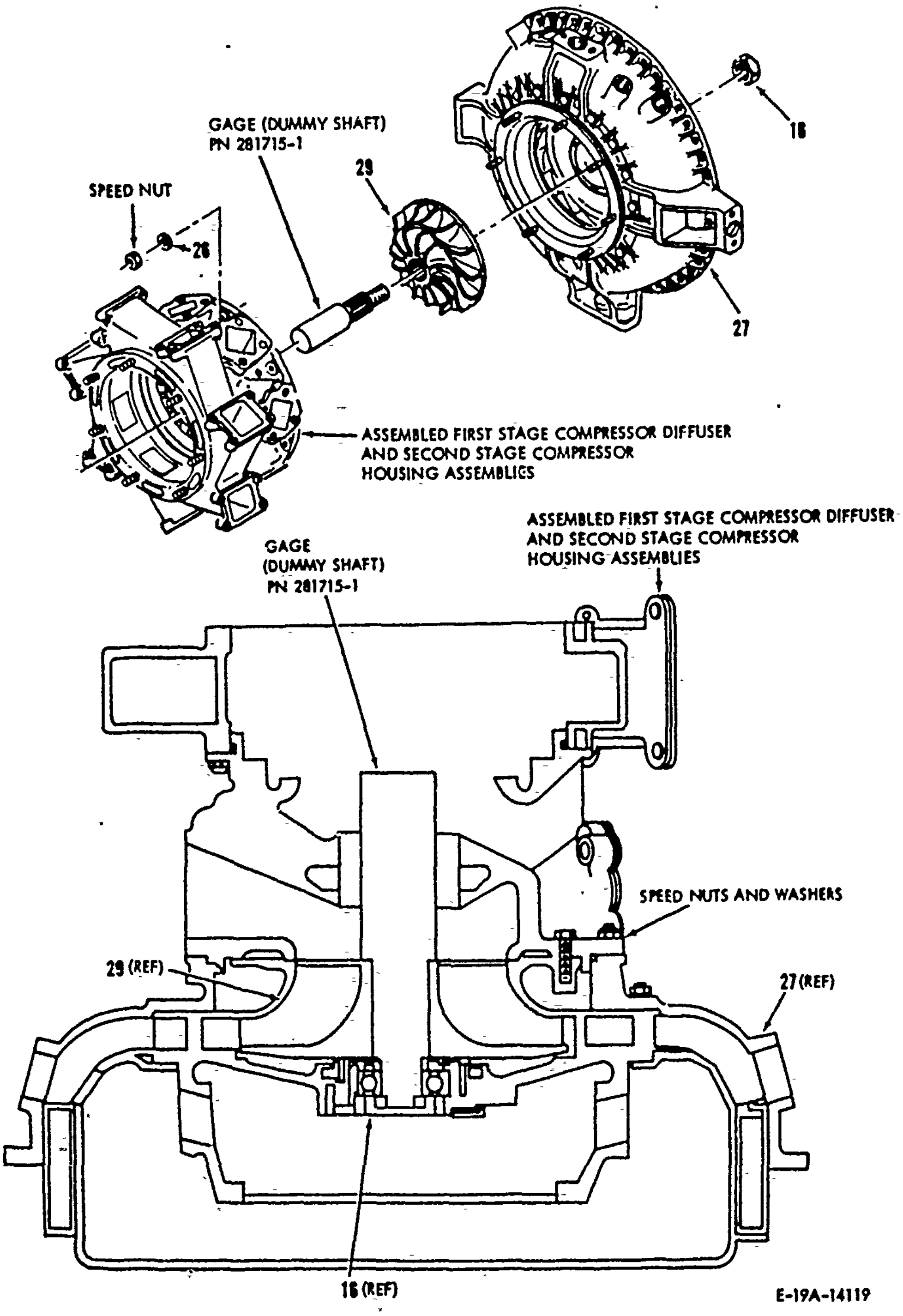

GAGE (DUMMY SHAFT)
PN 281715-1
29
18
SPEED NUT
28
27
ASSEMBLED FIRST STAGE COMPRESSOR DIFFUSER AND SECOND STAGE COMPRESSOR HOUSING ASSEMBLIES
ASSEMBLED FIRST STAGE COMPRESSOR DIFFUSER AND SECOND STAGE COMPRESSOR HOUSING ASSEMBLIES
GAGE (DUMMY SHAFT) PN 281715-1
SPEED NUTS AND WASHERS
29 (REF)
27 (REF)
18 (REF)
E-19A-14119

Figure 10. Install Second Stage Impeller

Key to Figure 10

16. Nut
26. Washer
27. Second stage diffuser housing assembly
29. Second stage impeller

d. Install Second Stage Impeller.

(1) Note dimension stamped on 281715-1 gage assembly (dummy shaft). Record as dimension K and retain for later use.

(2) Install second stage impeller (29, figure 10) in second stage diffuser housing assembly (27).

(3) Carefully lower assembled second stage compressor housing assembly and first stage compressor diffuser assembly into place over second stage diffuser housing assembly (27).

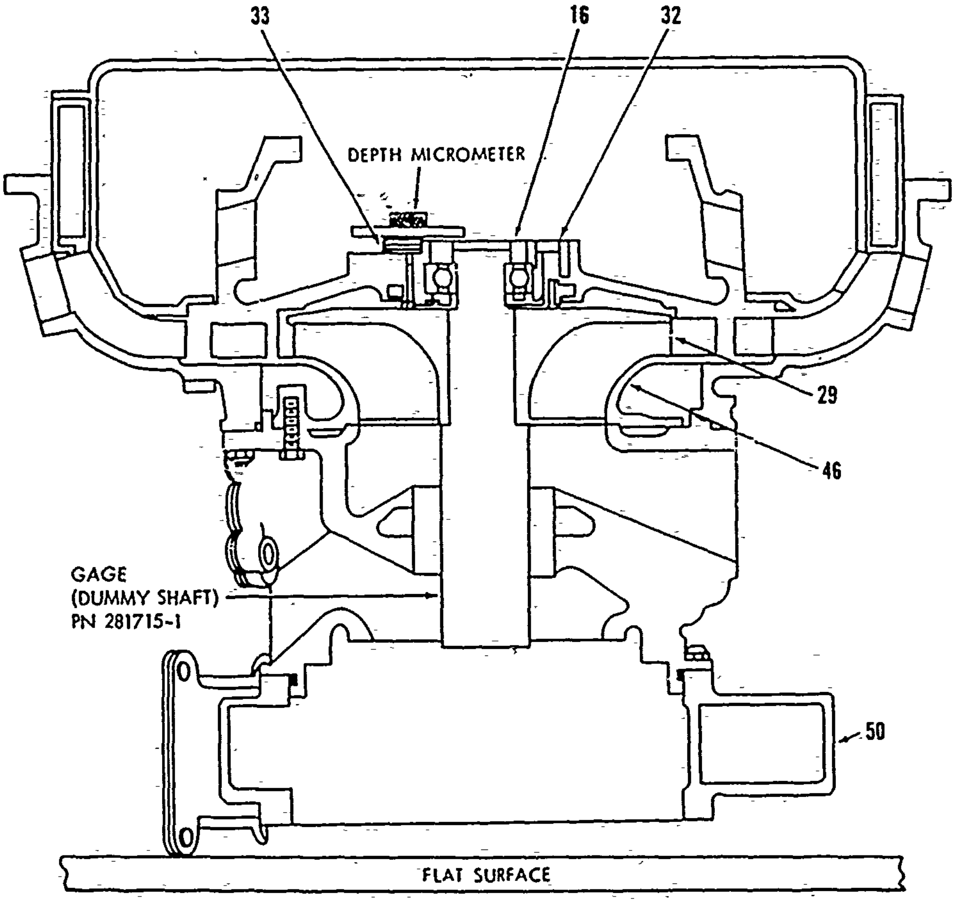
(4) Align index marks on housing assemblies.

(5) Install 281715-1 gage assembly (dummy shaft) in second stage impeller (29).

(6) Secure second stage compressor housing assembly to second stage diffuser housing assembly (27) using washers (26) and speed nuts.

(7) Place assembled housing assemblies on their sides and install nut (16).

737



16.	Nut	46.	Second stage impeller shroud assembly
29.	Second stage impeller	50.	First stage compressor diffuser assembly
32.	Compressor bearing retainer		
33.	Compressor bearing shim		

Figure 11. Determine Thickness of Shims Required for Clearance Between Second Stage Impeller and Second Stage Impeller Shroud Assembly

e. Determine Thickness of Shims Required for Clearance Between Second Stage Impeller and Second Stage Impeller Shroud Assembly.

(1) Place assembled housing assemblies on a flat surface with first stage compressor diffuser assembly (50, figure 11) down.

(2) Rotate 281715-1 gage assembly (dummy shaft) to check for slight tick between second stage impeller shroud assembly (46) and second stage impeller (29).

NOTE

All measurements shall be taken at notch mark on 281715-1 gage assembly (dummy shaft).

(3) Using a depth micrometer, measure from top surface of compressor bearing retainer (32) through a mounting hole to backface of second stage impeller (29). Record as dimension A. Note position and location where dimension A was taken. Remove one externally relieved bolt (30, figure 9).

(4) Using 280190 adapter, tighten nut (16, figure 11) and torque to 450 to 500 inch-pounds.

NOTE

The ideal clearance between second stage impeller (29) and second stage impeller shroud (46) is 0.014 to 0.016 inch.

CAUTION

Dimension B shall be taken in the same position and location as dimension A was taken. If not, results of second stage impeller (29) to second stage impeller shroud assembly (46) clearance will be affected.

(5) Measure from top surface of compressor bearing retainer (32) to backface of second stage impeller (29). Record as dimension B.

(6) Subtract dimension B from dimension A and subtract 0.010 to 0.020 inch.

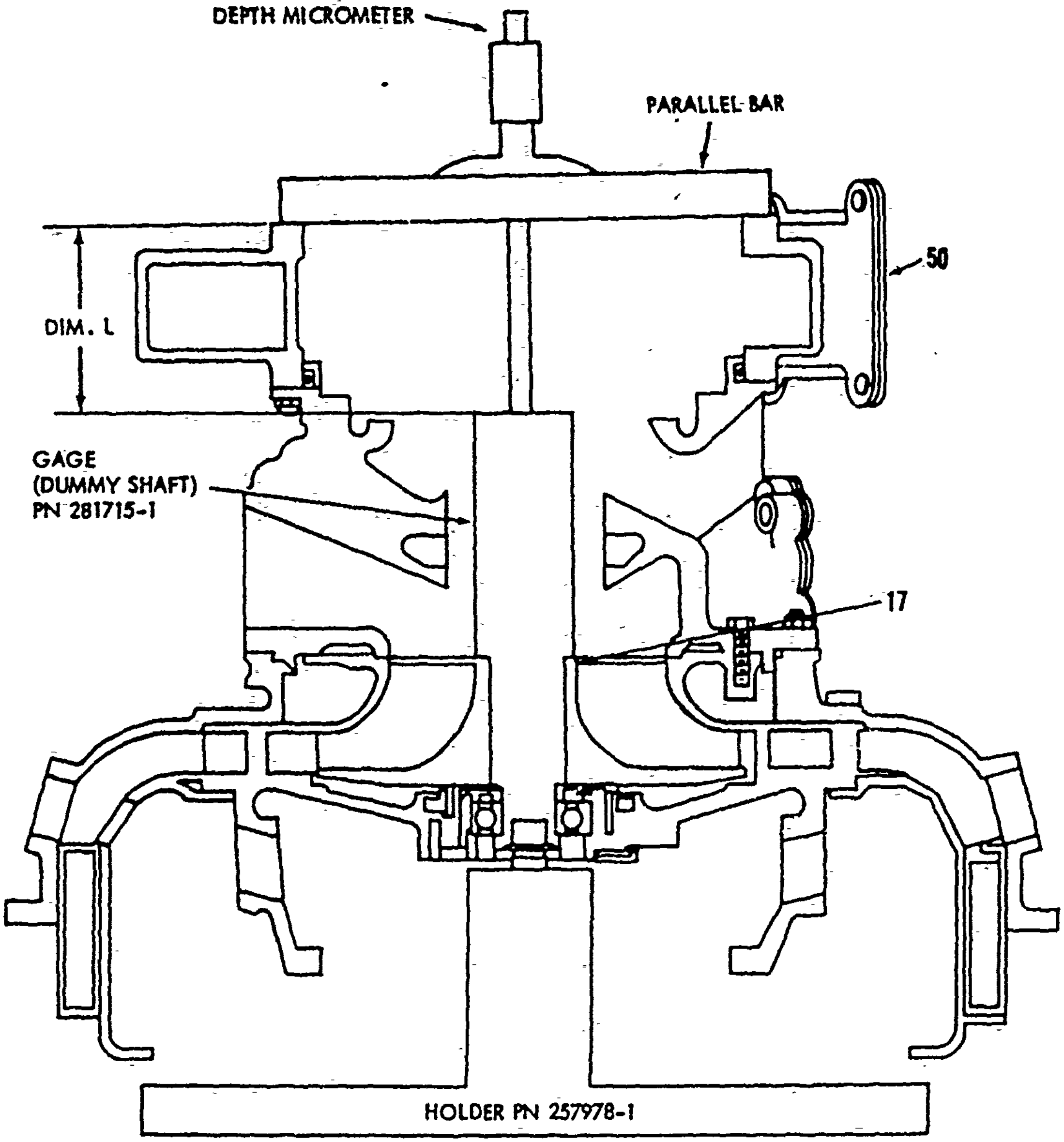
Formula. A - B (0.010 to 0.020 inch) = compressor bearing shims (33).

(7) Add or remove compressor bearing shims (33) as required to obtain 0.010 to 0.020 inch clearance between second stage impeller (29) and second stage impeller shroud assembly (46).

NOTE

Repeat steps (1) through (7) if compressor bearing shims (33) are added or removed.

739



F-19A-7281

Figure 12. Determine Thickness of Shims Required for Alignment of First Stage Compressor Impeller Assembly in First Stage Compressor Diffuser Assembly

740

f. Determine Thickness of Shims Required for Alignment of First Stage Compressor Impeller Assembly in First Stage Compressor Diffuser Assembly.

(1) Invert assembled housing assemblies and place on 257978-1 holder assembly with holder pilot supporting 281715-1 gage assembly (dummy shaft) and with first stage compressor diffuser assembly (50, figure 12) upward.

(2) Place parallel bar of known thickness across mounting flange of first stage compressor diffuser assembly (50).

(3) Using a depth micrometer, measure from top of parallel bar to top of 281715-1 gage assembly (dummy shaft).

(4) [redacted]g.

(5) Subtract thickness of parallel bar from average reading. Record as dimension L.

(6) Record dimension stamped on 281715-1 gage assembly (dummy shaft) as dimension K.

(7) Add dimension K to dimension L. Record as dimension M.

(8) Subtract dimension F, as recorded in step 8f(6), from dimension M. Record as dimension X.

(9) Subtract dimension X from dimension J recorded in paragraph 8a(5). Record as dimension Y.

(10) [redacted] Record total as dimension Z. Dimension Z equals total thickness of shims (17) required.

Formula: $L + K = M$
$M - F = X$
$J - X = Y$
$Y + (0.005 \text{ to } 0.010 \text{ inch}) = Z$
$Z =$ Total thickness of shims (17)

(11) Record thickness of shims (17) for later use.

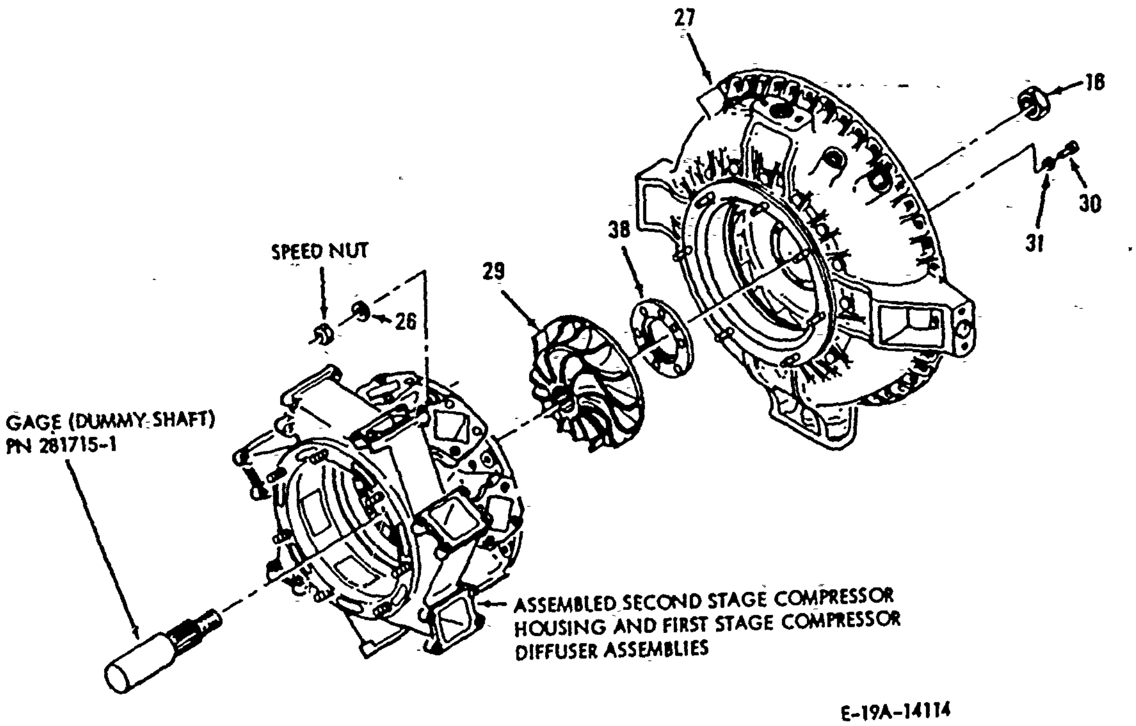

27
18
30
31
38
29
SPEED NUT
26
GAGE (DUMMY SHAFT)
PN 281715-1
ASSEMBLED SECOND STAGE COMPRESSOR HOUSING AND FIRST STAGE COMPRESSOR DIFFUSER ASSEMBLIES
E-19A-14114

Figure 13. Separate Assembled Housing Assemblies

742

g. Separate Assembled Housing Assemblies.

(1) Using 280190 adapter, remove nut (16, figure 13).

(2) Remove 281715-1 gage assembly (dummy shaft) and second stage impeller (29).

(3) Remove speed nuts and washers (26).

(4) Carefully lift assembled second stage compressor housing assembly and first stage compressor diffuser assembly from second stage diffuser housing assembly (27).

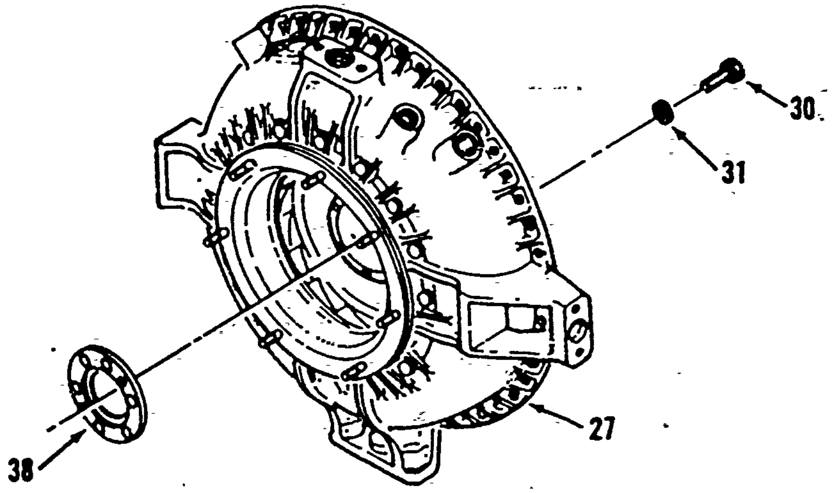
NOTE

> Retain second stage impeller (29) and rotating group with housing assemblies as it is now a measured and matched component.

(5) Remove second stage impeller (29).

(6) Remove rotor off compressor seal assembly (38).

(7) Remove temporarily installed externally relieved bolts (30), washers (31), compressor bearing retainer (32, figure 9), compressor bearing shims (33, 37), assembled bearing mount assembly (35), bearing (34) and dummy stator of compressor seal assembly (38, figure 13) from second stage diffuser housing assembly (27).



E-19A-14115

Figure 14. Install Compressor Seal Rotor

744

h. Install Compressor Seal Rotor.

WARNING

Lube oil may contain tricresyl phosphate. This additive is poisonous and can be readily absorbed through the skin. Make certain that this oil does not remain on the skin. The oil may burn if exposed to heat or flames. Use only in a well-ventilated area. Neoprene gloves and face shield/safety goggles shall be worn.

CAUTION

Use clean lint-free gloves when handling jet engine carbon seals and anti-friction bearings to prevent damage to seal and bearing surfaces from fingerprints.

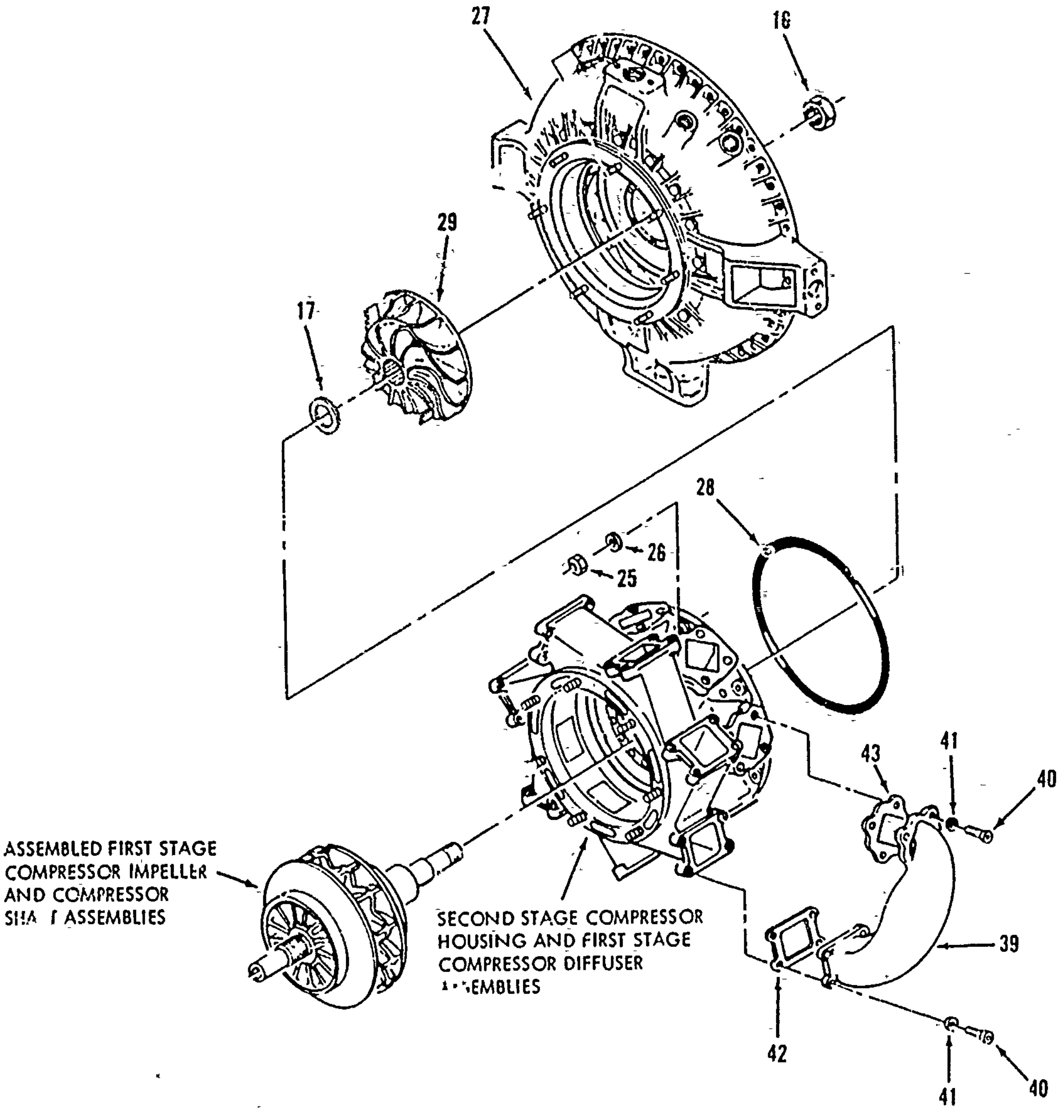
(1) Apply a light film of oil (53-62) to dummy rotor portion of compressor seal assembly (38, figure 14).

(2) Install compressor seal assembly (38) into second stage diffuser housing assembly (27).

(3) Install assembled bearing (34, figure 9), bearing mount assembly (35), compressor bearing shims (33, 37), compressor bearing retainer (32) and secure to compressor seal assembly (38, figure 14) with washers (31) and externally relieved bolts (30).

(4) Tighten externally relieved bolts (30) and torque to 20 to 25 inch-pounds.

745


27
16
29
17
28
26
25
43
41
40
ASSEMBLED FIRST STAGE COMPRESSOR IMPELLER AND COMPRESSOR SHAFT ASSEMBLIES
SECOND STAGE COMPRESSOR HOUSING AND FIRST STAGE COMPRESSOR DIFFUSER ASSEMBLIES
39
42
41
40
E-19A-14118

16. Nut
17. Shim
25. Nut
26. Washer
27. Second stage diffuser housing assembly
28. Packing
29. Second stage impeller
39. Interstage air duct
40. Screw
41. Washer
42. Gasket
43. Gasket

Figure 15. Install Rotating Assembly

i. Install Rotating Assembly.

NOTE

Duct Part No. 372696 is manufactured by two (2) methods: rough texture and smooth in appearance. Select a set of either type. "Do not mix."

(1) Install interstage air ducts (39, figure 15) and gaskets (42, 43). Ensure that interstage air duct (39) passages are aligned with mating passages.

NOTE

Each insert for screws (40) shall have a minimum of 5 inch-pounds frictional torque.

(2) Install bolt in helicoil until locking device is contacted. using a standrad torque wrench, measure frictional torque prior to installing screws (40).

NOTE

Use only screws (40) with a new or like new internal wrenching heads and allow 2 to 4 hours cure time to sealing compound (53-39) at room temperature before running engine.

(3) Apply sealing compound (53-39) to threads of screws (40).

(4) Secure interstage air ducts (39) with screws (40) and washers (41).

(5) Using 231714-1 adapter assembly, tighten screws (40) and torque to 30 to 35 inch-pounds plus frictional torque.

WARNING

Handling hot items presents a serious burn potential. Non-asbestos heat resistant gloves shall be worn.

(6) Place second stage impeller (29) in an oven heated to 400°F (204°C) for approximately 15 minutes.

WARNING

Dry ice is solid CO^2 that has a temperature well below zero C (-80°C). Skin contact with dry ice will cause serious low temperature burns. Temperature resistant gloves and apron shall be used when handling. Carbon dioxide displaces oxygen which can cause asphyxiation. Use only in a well-ventilated area.

(7) Place rotating assembly in dry ice (53-43) for approximately 10 minutes.

(8) Install rotating assembly on 257978-1 holder assembly with first stage compressor impeller assembly downward and 281508-1 pilot (part of holder assembly) placed on compressor shaft assembly.

(9) Coat splines of compressor shaft assembly with grease (53-48A). Carefully guide assembled second stage compressor housing assembly and first stage compressor diffuser assembly onto compressor shaft assembly. Remove pilot.

(10) Install thickness of shim (17, figure 15 continued), determined in step f(10), onto second stage impeller mounting shoulder of compressor shaft assembly.

(11) Hold heated second stage impeller (29) with gloves and press second stage impeller (29) onto compressor shaft assembly.

(12) Remove assembled compressor components from holder assembly.

NOTE

Ensure packing (28) has been installed on second stage compressor housing assembly.

(13) Install second stage diffuser housing assembly (27) on 281726-1 adapter assembly and 257978-1 holder assembly.

CAUTION

Ensure that index marks on housing assemblies are aligned to maintain previously checked concentricity of bearing bores.

(14) Carefully place assembled compressor components in second stage diffuser housing assembly (27), allowing compressor shaft assembly to start into bearing and allowing studs to start into holes of second stage compressor housing assembly.

CAUTION

Bearing in second stage diffuser housing assembly shall be supported to prevent bearing damage during installation of compressor components.

(15) Use a rubber mallet to drive compresor shaft assembly into bearing.

NOTE

Allow 2 to 4 hours cure time to sealing compound (53-39) at room temperature before running engine.

(16) Apply sealing compound (53-39) on stud threads and install nuts (25) and washers (26).

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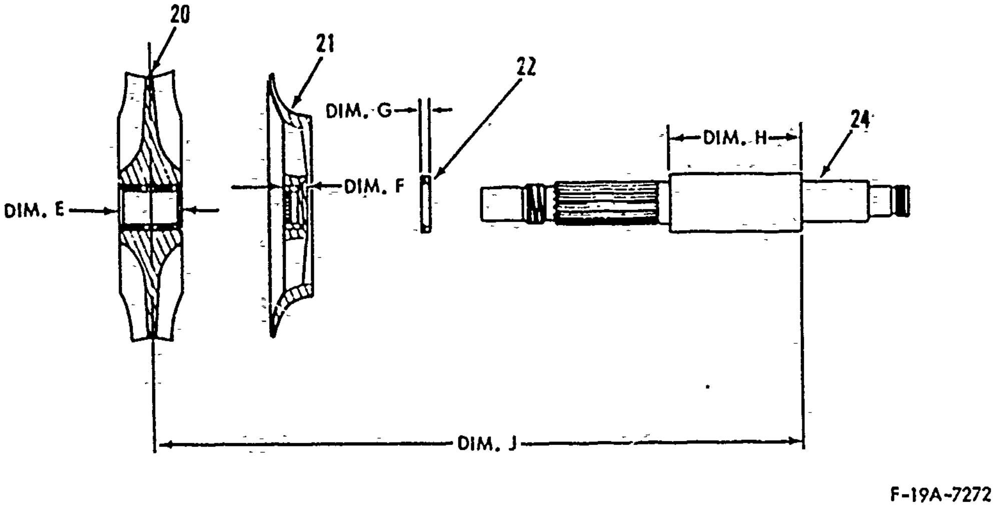

20.	Wheel	22.	Shim
21.	Inducer	24.	Compressor shaft

Figure 1. Impeller Assembly and Compressor Shaft Assembly Measurements

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8. PREASSEMBLY.

a. Impeller Assembly and Compressor Shaft Assembly Measurements.

(1) Measure thickness of hub of wheel (20, figure 1). Record as dimension E. Divide dimension E by two and record as dimension E/2.

(2) Measure thickness of hub of (first stage) inducer (21) (inducer with large chamfer on inside diameter of end of hub). Record as dimension F.

(3) Measure length of compressor shaft (24) between mounting shoulders for impeller assembly and second stage impeller [redacted]. Record average length as dimension H.

(4) Measure thickness of shim (22). Record as dimension G.

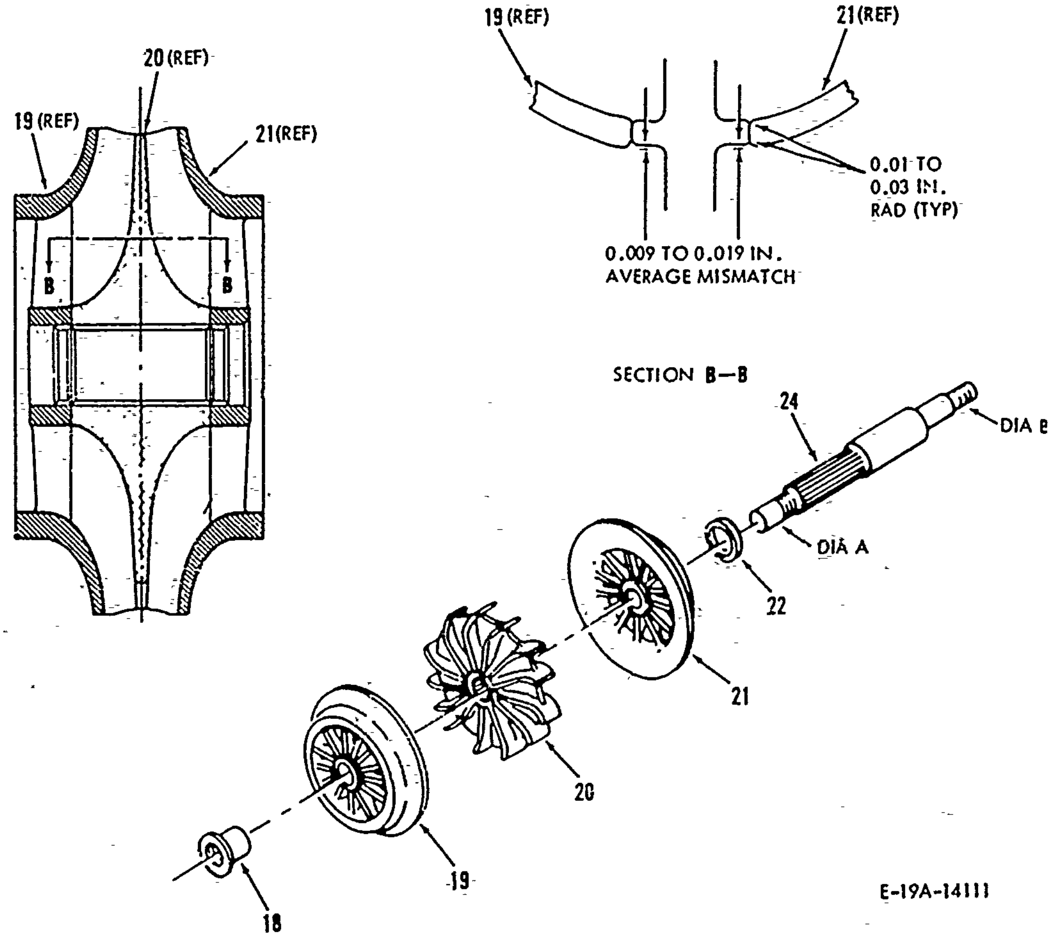
NOTE

Average dimension J is 5.520 + 0.010 - 0.020 inches.

(5) Add dimensions E/2, F, G and H. Record as dimension J. This dimension represents the distance from centerline of impeller assembly to mounting shoulder of second stage impeller.

Formula: $E/2 + F + G + H = J$

(6) Tag measured parts with dimension J for later use.



18. Round plain nut
19. Inducer
20. Wheel
21. Inducer
22. Shim
24. Compressor shaft

Figure 2. Assemble First Stage Compressor Impeller Assembly and Compressor Shaft Assembly (Rotating Assembly)

b. Assemble First Stage Compressor Impeller Assembly and Compressor Shaft Assembly (Rotating Assembly).

(1) Install shim (22, figure 2) on compressor shaft (24).

(2) For first stage compressor impeller assembly, align index marks on inducers (19, 21) and wheel (20). For first stage compressor assembly with no visible index marks, select the relative position of the blades of inducers (19, 21) and wheel (20) in accordance with section B-B, figure 2.

WARNING

Handling hot items presents a serious burn potential. Non-asbestos heat resistant gloves shall be worn.

NOTE

To ease the installation of the first stage compressor impeller assembly (19, 20, 21) on the compressor shaft (24), the compressor impeller assembly may be heated.

(3) Place the first stage compressor impeller assembly (19, 20, 21) in an oven heated to 400°F (204°C) for 10 to 15 minutes.

(4) Remove first stage compressor impeller assembly (19, 20, 21) from oven.

(5) Ensure first stage compressor impeller assembly (19, 20, 21) components are properly aligned in accordance with section B-B, figure 2.

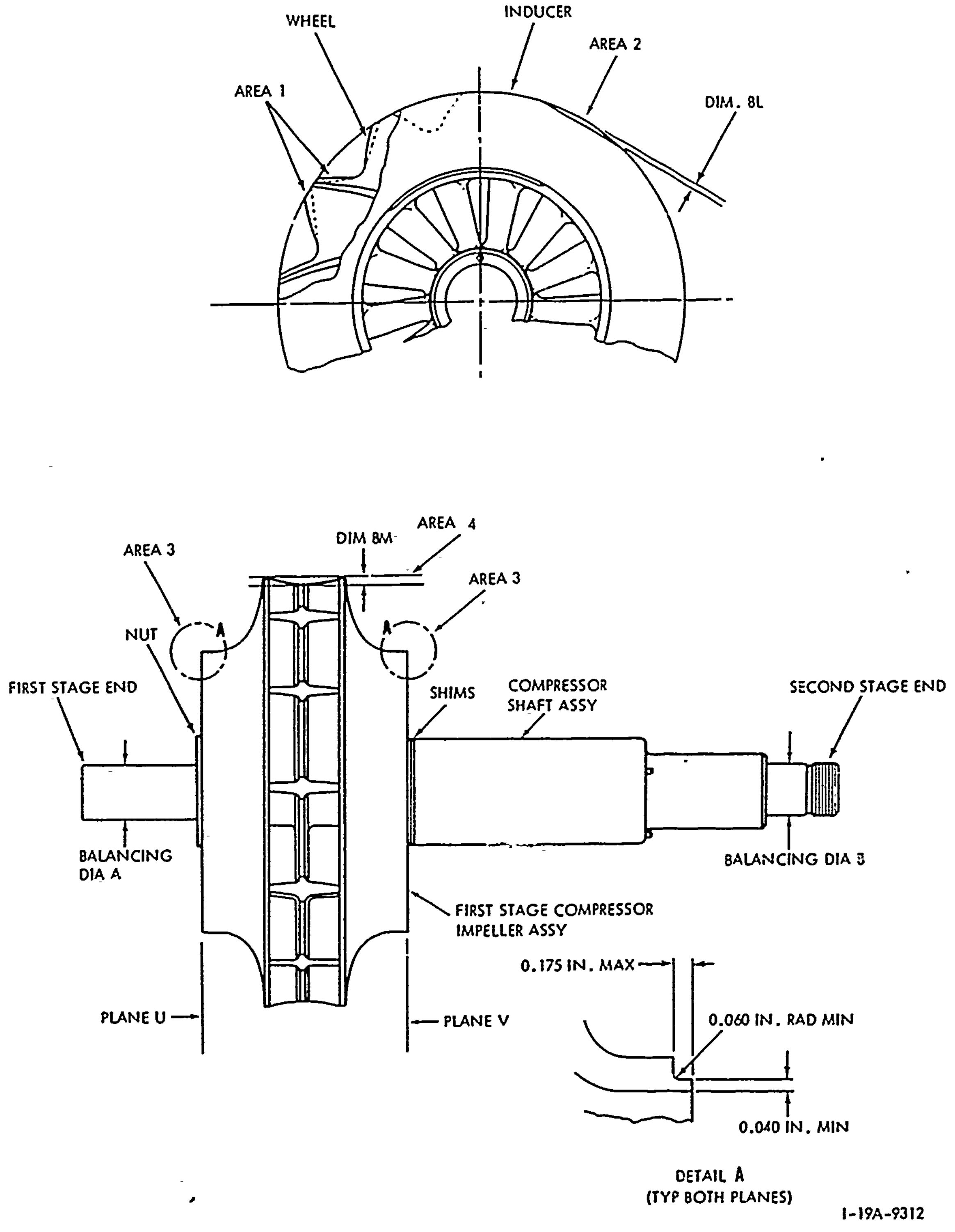
NOTE

Inducer (21) has a large chamfer on the inside diameter of the hub end which shall be installed towards shim (22) installed on compressor shaft (24) shoulder.

(6) Install first stage compressor impeller assembly (19, 20, 21) over splines on compressor shaft (24) with inducer (21) toward shim (22).

(7) Allow assembled first stage compressor impeller assembly (19, 20, 21), shim (22) and compressor shaft (24) to cool to room temperature.

(8) Ensure first stage compressor impeller assembly (19, 20, 21) is aligned in accordance with section B-B, figure 2 and install round plain nut (18) on compressor shaft (24) finger tight.



DIM. 8L 0.100 inch
DIM. 8M 0.098 to 0.102 inch

Figure 3. Rotating Assembly Runout and Balance Procedures

c. Rotating Assembly Runout and Balance Procedures.

(1) Rotating assembly runout. (See figure 3.)

(a) Install rotating assembly in 281717-1 holder assembly and tighten holder nut finger tight.

(b) Install 281717-1 holder assembly in a hydraulic press. Apply a clamping force of 2000 pounds and tighten holder nut finger tight.

(c) Release the 2000 pounds clamping force and remove 281717-1 holder assembly from hydraulic press.

(d) Using 284327-1-1 adapter assembly, tighten round plain nut (18, figure 2) and torque to 95 to 105 foot-pounds.

(e) Install 281717-1 holder assembly in a hydraulic press. Apply a clamping force of 2000 pounds and loosen holder nut.

(f) Release the 2000 pounds clamping force and remove 281717-1 holder assembly from hydraulic press.

(g) Remove rotating assembly from 281717-1 holder assembly.

(h) Using a surface plate and v-blocks, support the rotating assembly on balancing diameters A and B, figure 3.

(i) Using a dial indicator supported from the surface plate, check rotating assembly compressor shaft (24, figure 2) at a point immediately adjacent to the first stage impeller assembly shims (22).

(j) [redacted]

(k) If runout is within specified limits proceed to step (r). If runout is excessive, repeat steps (a), (b), (c) and proceed to step (l).

(l) Using 284327-1-1 adapter assembly, loosen round plain nut (18).

(m) Repeat steps (e), (f), (g) and proceed to step (n).

(n) Remove round plain nut (18) from compressor shaft (24).

NOTE

First stage compressor impeller assembly may be rotated on compressor shaft (24, figure 2 continued) splines any number of teeth and/or degrees in either direction provided the specified requirements of section B-B, figure 2 and steps (b) through (j) are maintained.

(o) Raise first stage compressor impeller assembly from compressor shaft (24) splines and rotate.

NOTE

Ensure first stage compressor impeller assembly (19, 20, 21) components are aligned in accordance with section B-B, figure 2.

(p) Reinstall the first stage compressor impeller assembly (19, 20, 21) on splines of compressor shaft (24) and secure with round plain nut (18) tightened finger tight.

(q) Repeat steps (a) through (j) and (l) through (p) until requirements of step (j) are met.

(r) Repeat steps (e), (f), (g).

(s) Using 284327-1-1 adapter assembly, remove round plain nut (18).

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CAUTION

Do not apply sealing compound (53-38) to threaded area of compressor shaft (24) or to threads of round plain nut (18).

NOTE

Ensure cavity between inside diameter of first stage compressor impeller assembly (19, 20, 21) and outside diameter of compressor shaft (24) is filled with sealing compound (53-38) to just below threads of compressor shaft (24).

(t) Using an eye dropper, fill the cavity between inside diameter of first stage compressor impeller assembly (19, 20, 21) and outside diameter of compressor shaft (24) with sealing compound (53-38). Ensure no sealing compound (53-38) is applied to threads of compressor shaft (24).

(u) Reinstall round plain nut (18) on compressor shaft (24).

(v) Repeat steps (d) through (g).

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(w) Remove excess sealing compound (53-38) from the rotating assembly and allow rotating assembly to stand in a vertical position with the impeller assembly upward for a minimum of 10 minutes.

WARNING

Handling hot items presents a serious burn potential. Non-asbestos heat resistant gloves shall be worn.

(x) Maintain the vertical position with the impeller up and place the rotating assembly in an oven heated to 260-290°F (126-143°C) for a minimum of 1 hour.

WARNING

Handling hot items presents a serious burn potential. Non-asbestos heat resistant gloves shall be worn.

(y) Remove rotating assembly from oven and place on a suitable bench maintaining the vertical position with the impeller up. Allow to cool to room temperature.

(z) Using a surface plate and v-blocks, support the rotating assembly on balancing diameters A and B, figure 3.

(aa) Using a dial indicator supported from the surface plate, check rotating assembly compressor shaft (24, figure 2) at a point immediately adjacent to the first stage impeller assembly shims (22).

(ab) [redacted]. If runout is within specified limits, proceed to step (af). If runout is excessive repeat steps (a), (b), (c) and (n). Proceed to step (ac).

(ac) Remove first stage compressor impeller assembly (19, 20, 21) from compressor shaft (24).

(ad) Clean sealing compound (53-38) from the first stage compressor impeller assembly (19, 20, 21) bore, compressor shaft (24) and shims (22) in accordance with T.O. 2G-GTCP85-53-5.

(ae) Repeat steps (p) through (ab).

(af) Mark dimension J recorded in step a.(5) with industrial marking ink (53-52).

(2) Balance rotating assembly.

NOTE

Tools called out in the following procedures are for use with a standard 1S or 13S Gisholt balancing machine.

(a) Place 256377-3 insert assembly on balancing diameter A, figure 3 and 256377-11 insert assembly on balancing diameter B.

(b) Install rotating assembly, 256377-3 insert assembly and 256377-11 insert assembly on balancing machine.

CAUTION

Do not allow the rotating assembly to rub the supports or half bushing ends. Keep the rotating assembly level and use end stops to prevent rubbing.

(c) Using 284383-1-1 driver assembly, spin the rotating assembly on the balancing machine. Record the amount of the unbalance and locate the angles of planes U and V, figure 3.

(d) [redacted]

[redacted]

(f) Remove the rotating assembly from the balancing machine.

WARNING

Grinding operations create metal particles which may enter the eye. Wearing of goggles/face shield is required. Ventilation requirements will be determined by the base Bioenvironmental Engineers. Respiratory protection will be determined by the base Bioenvironmental Engineers.

Machining operations create metal particles which could enter the eye. Safety goggles shall be worn.

NOTE

All surfaces where material is removed must blend smoothly and have a surface finish of 63 microinches or better. Corners and/or edges must not be sharper than 0.005 to 0.015 inch radius.

(g) Machine or grind to remove material from planes U and V, figure 3, as required. Remove material in the following sequence steps (h), (i), (j) at the locations recorded in step (c).

(h) Remove material from wheel in area 1 until balance is 0.007 ounce-inch.

(i) Remove material from area 2 within limits of dimension BL.

(j) Remove material from area 4 within limits of dimension BM.

NOTE

Use 281461-1 filing assembly for best results and control of material removal from detail A.

(k) Using 281461-1 filing assembly, remove material from area 3 within limits of detail A.

(l) Recheck balance in accordance with steps (b) through (e).

(m) Remove the rotating assembly from the balancing machine.

(n) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(o) Corrosion treat reworked area in accordance with T.O. 1-1-2.

(p) Tag rotating assembly as BALANCED and package in accordance with MIL-P-116.

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(3) Install new exducer. (See figure 3, sheet 2.)

(a) Check exducer blade leading edge to see if corner has been removed. Those exducers not having corner removed will be reworked maintaining specified limits of dimension BQ and angle BR prior to being installed on turbine wheel.

(b) Stack parts, wheel, exducer and new ring and tap with soft hammer to ensure all parts are properly seated.

(c) Check for parallelism. Rotate exducer on wheel to get best parallel position.

(d) Align the wheel, ring and exducer in 287216-1-1 holder and driver assembly so that misalignment of wheel and exducer blades is within limits of dimension X.

(e) Recheck parallelism and tap exducer to assure all parts are properly seated.

CAUTION

Do not exceed 200,000 pounds force.

(f) Press assembly together by gradually applying an axial force to a maximum of 200,000 pounds force. Press in one continuous operation at a minimum pressing rate of 30 seconds to specified limits.

(g) Dimension X is measured at four equally spaced locations around circumference of rotating assembly. Dimension X shall be within specified limits.

(h) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(i) Apply corrosion preventative compound (53-31A) to reworked area.

(j) When exducer and wheel are assembled, machine or grind contour of exducer blades to wheel vanes using table of coordinates.

(k) Balance in accordance with step h.

h. Balance Turbine Rotating Assembly. (See figure 4.)

NOTE

Tools called out in the following procedure are for use on a standard 1S or 13S Gisholt balancing machine. Equivalent balancing machines and applicable tooling may be used.

(1) Deleted.

(2) Using 280994 support assembly, mount turbine rotating assembly in balance machine.

(3) [redacted] Non-jet air type balancing machines are to be rotated at approximately 1200 rpm.

(4) ~~Balance shall be accurate within 0.010 ounce inch in planes M and N.~~

(5) Material may be removed to obtain balance in the following sequence.

(a) Material may be removed from surface C (area 1) within limits shown.

1 All surfaces where material has been removed shall blend smoothly and have a surface finish of 32 microinches or better. Corners of edges shall not be sharper than 0.015 inch radius.

(b) Material may be removed from surface K (area 2) within limits shown.

1 All surfaces where material has been removed shall blend smoothly and have a surface finish of 32 microinches or better. Corners of edges shall not be sharper than 0.015 inch radius.

(6) Apply corrosion preventative compound (53-31A) to reworked area.

(7) Package in accordance with MIL-P-116 to prevent damage.

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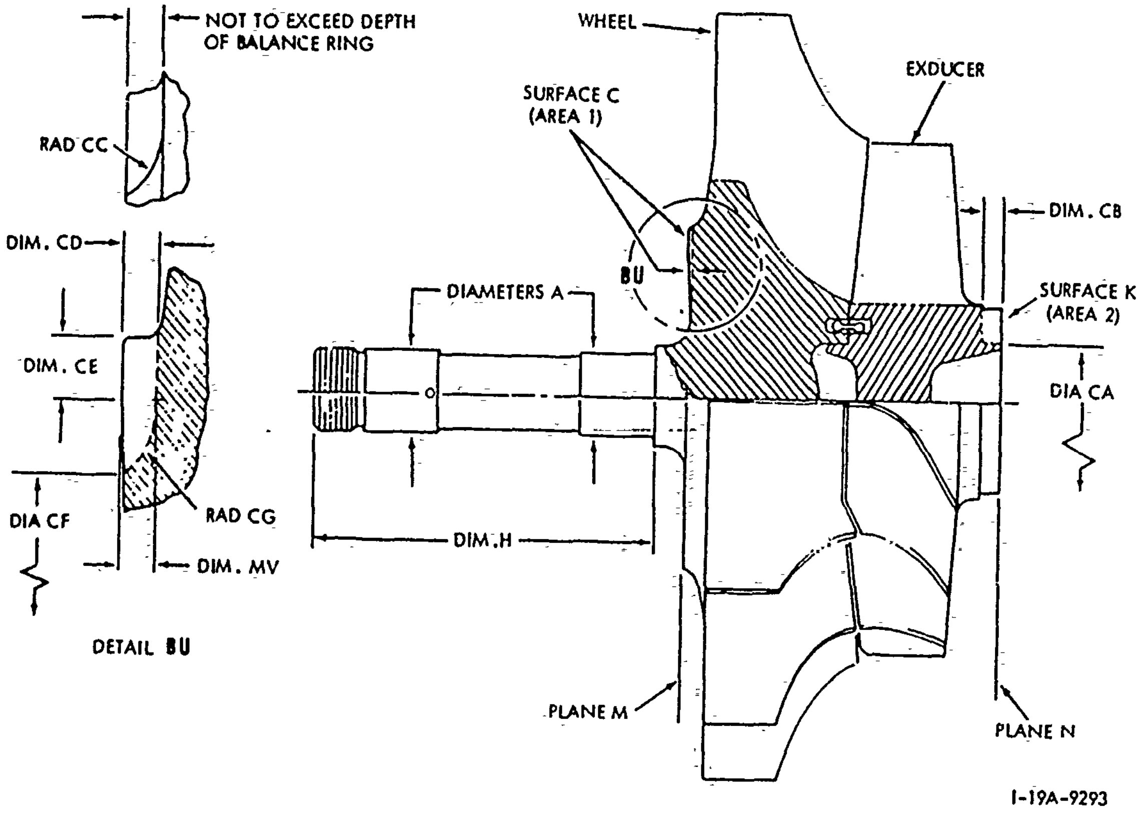


DIA A	0.9844 to 0.9846 inch
DIM. H	3.950 to 3.975 inches
DIA CA	1.30 inches minimum
DIM. CB	0.25 inch maximum
RAD CC	0.250 inch minimum

DIM. CD	0.125 inch maximum
DIM. CE	0.298 inch maximum
DIA CF	3.000 inches minimum
RAD CG	0.250 inch minimum
DIM. MV	0.060 inch maximum

Figure 4. Turbine Rotating Assembly (Rotating Assembly) - Balancing

6. PARENT METAL.

Nomenclature	Material	Specification
First Stage Compressor Impeller Assembly	-	-
Wheel	-	-
378101-3	Aluminum Alloy 2214-T6	-
378101-70	Titanium Ti-6A-4V	AMS4928
Inducers	Titanium Ti-6A-4V	AMS4928

7. REPAIR.

a. Repair Inducers and Wheel.

(1) Blend minor nicks, scratches or burrs in accordance with WP 003 00.

(2) Corrosion treat reworked area in accordance with WP 003 00.

(3) Balance in accordance with step c.

b. Repair Inducers. (See figure 1.)

(1) Repair cracks, erosion or wear on contour.

(a) Damage and/or cracks may be blended by machining, grinding or by hand using abrasive cloth (53-2) maintaining limits of dimension AA.

(b) Corrosion treat reworked area in accordance with WP 003 00.

(c) Balance in accordance with step c(1).

(2) Repair damaged blade leading edge.

(a) Damage and/or cracks may be removed by machining, grinding or by hand using abrasive cloth (53-2) within limits of dimension AB and radius AC. Leading edge shall have full radius. Material removal shall be done equally to both inducers.

(b) Corrosion treat reworked area in accordance with WP 003 00.

(c) Balance in accordance with step c(1).

c. Balance Inducers and Wheel. (See figure 2.)

NOTE

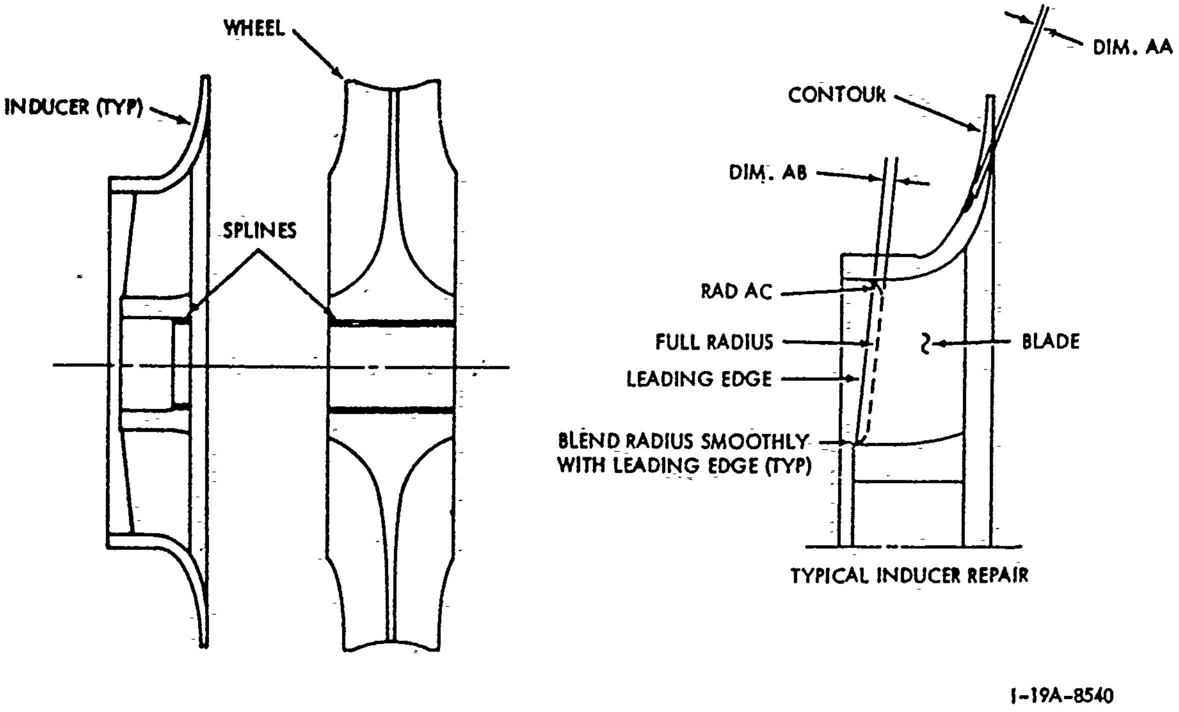
Tools called out in the following procedure are for use on a standard 1S or 13S Gisholt balancing machine.

(1) Balance inducer in accordance with WP 003 00, paragraph 7s. (Inducers and Wheel Part No. 378101-3/70 can be balanced as a rotating group in accordance with T.O. 2G-GTCP85-53-8, WP 003 00.)

(a) Install inducer on a mandrel selected from 281583 mandrel assembly and place in standard balancing machine using two 256377-7 inserts.

(b) Using 284383-1-1 drive assembly, start balancing machine and check dynamic balance. Balance must be within 0.0030 ounce-inch in planes L and M.

12.5 lbs



DIM. AA 0.020 inch maximum
DIM. AB 0.120 inch maximum

RAD AC 0.035 to 0.045 inch

Figure 1. First Stage Compressor Impeller Assembly (Impeller Assembly) - Repair

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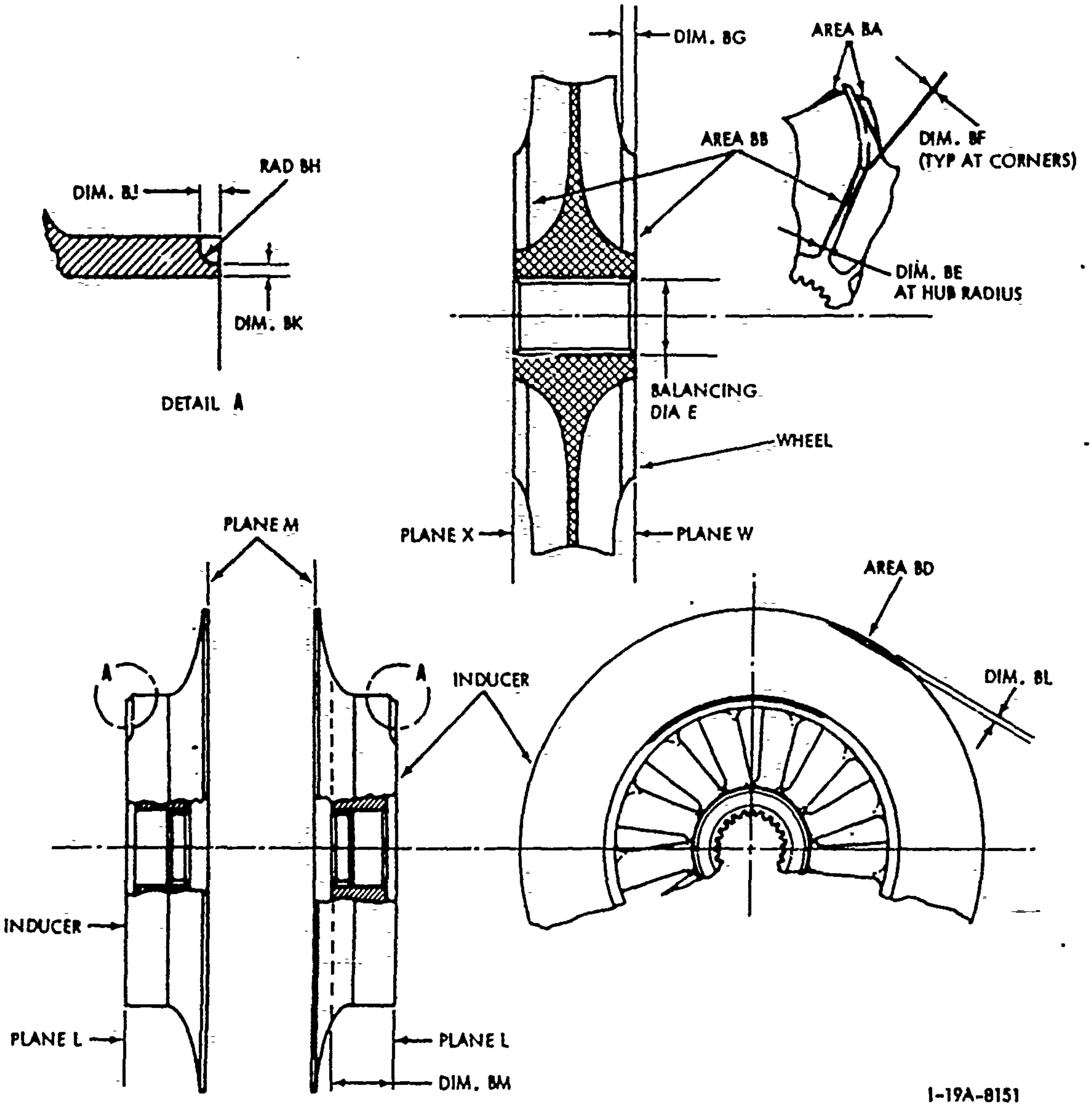

DIM. BE	0.0 inch	DIM. BJ	0.095 inch maximum
DIM. BF	0.005 inch maximum	DIM. BK	0.040 inch minimum
DIM. BG	0.200 inch maximum	DIM. BL	0.100 inch maximum
RAD BH	0.060 inch maximum	DIM. BM	0.988 inch minimum

Figure 2. First Stage Compressor Impeller Assembly (Impeller Assembly) - Balance

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(c) If balance cannot be done in accordance with detail A, plane L can be cut back to dimension BM to re-establish dimension BK.

(d) Remove material, if required, maintaining specified limits to obtain balance requirements. Reworked areas must blend smoothly with a finish of 63 microinches or better. Cut sharp corners or edges to radius of 0.015 inch or greater.

<u>1</u> Install inducer in 281460-1 holder assembly to remove metal from areas BB between inducer blades.

<u>2</u> Use 281461-1 filing assembly to remove metal from area in detail A.

(e) After dynamic balance is complete, check static balance at 180 degrees. Unbalance shall not exceed 0.020 ounce-inch in plane L and 0.025 ounce-inch in plane M.

(f) When balance requirements have been met, remove balancing setup.

(g) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(h) Corrosion treat reworked area in accordance with WP 003 00.

(i) Package in accordance with MIL-P-116 to prevent damage.

(2) Balance wheel in accordance with WP 003 00, paragraph 7s.

(a) Install wheel on a mandrel selected from mandrel set and place in standard balancing machine using two 256377-7 inserts.

(b) Using a 284383-1-1 drive assembly, start balancing machine and check dynamic balance. Balance must be within 0.0025 ounce-inch in planes W and X.

(c) Remove material, if required, in areas BA and BB maintaining specified limits to obtain balance requirements. Reworked surfaces must blend smoothly to finish of 63 microinches or better. Cut sharp corners or edges to radius of 0.015 inch or greater.

(d) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(e) Corrosion treat reworked area in accordance with WP 003 00.

(f) Package in accordance with MIL-P-116 to prevent damage.

SHAFT ASSEMBLY, COMPRESSOR
PART NO. 371690-10

1. NDI REQUIRED. Optional.

2. APPLICABLE SUPPORT EQUIPMENT. None.

3. REFERENCE MATERIAL REQUIRED.

Non-Destructive Inspection (NDI) Requirements	WP 005 00 This Manual
Repair Instructions, Depot Maintenance Manual	T.O. 2G-GTCP85-53-7, WP 003 00, 004 00
Standard Practices	WP 003 00 This Manual

4. CONSUMABLE MATERIALS. None.

5. ILLUSTRATED SUPPORT EQUIPMENT. None.

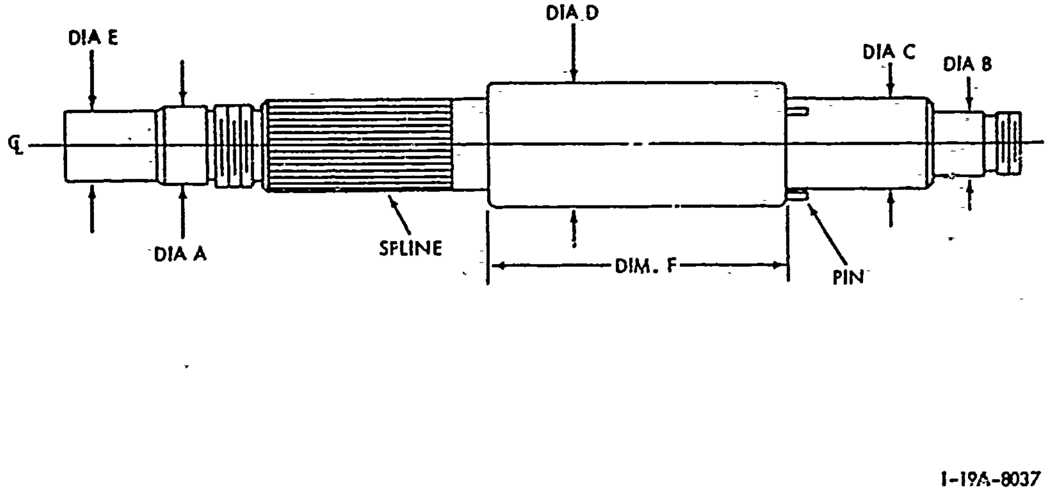

Figure 1. Compressor Shaft Assembly (Shaft Assembly) - Inspection

6. INSPECTION PROCEDURE.

NOTE

Spline wear measurement shall be made only if visual inspection indicates wear.

If cracks are suspected during visual inspection, mark area (refer to CAUTION prior to paragraph 7.a in WP 003 00) and perform magnetic particle inspection in accordance with WP 005 00. If all inspection requirements have passed, part will be considered serviceable.

Inspect	Serviceable Limits	Reparable Limits	Corrective Action
a. Visually			
(1) Cracks	No cracks allowed.	--	Replace shaft assembly.
(2) Diameters A through E for scoring and gouging.	No damage allowed.	--	Repair in accordance with T.O. 2G-GTCP85-53-7, WP 004 00.
(3) Splines cracked, broken or chipped.	No damage allowed.	--	Replace shaft assembly.
(4) Threads			
(a) Cracked, broken, crossed or stripped.	No damage allowed.	--	Replace shaft assembly.
(b) Dry film lubricant.	No damage allowed.	--	Repair in accordance with T.O. 2G-GTCP85-53-7, WP 003 00.
(5) Loose, missing or damaged pins.	No loose, missing or damaged pins allowed.	--	Repair in accordance with T.O. 2G-GTCP85-53-7, WP 004 00.

Inspect	Serviceable Limits	Reparable Limits	Corrective Action
b. Dimensionally			
(1) Diameter A	0.8695 to 0.8700 inch.	0.839 inch minimum.	Repair in accordance with T.O. 2G-GTCP85-53-7, WP 004 00.
(2) Diameter B	0.7872 to 0.7876 inch.	0.757 inch minimum	Repair in accordance with T.O. 2G-GTCP85-53-7, WP 004 00.
(3) Diameter C	1.1570 to 1.1574 inches.	1.127 inches minimum.	Repair in accordance with T.O. 2G-GTCP85-53-7, WP 004 00.
(4) Diameter D	1.624 to 1.625 inches.	1.595 inches minimum.	Repair in accordance with T.O. 2G-GTCP85-53-7, WP 004 00.
(5) Diameter E	0.8669 to 0.8674 inch.	0.837 inch minimum.	Repair in accordance with T.O. 2G-GTCP85-53-7, WP 004 00.
(6) Dimension F	3.750 to 3.760 inches.	--	Replace shaft assembly.
(7) External splines.	0.007 inch maximum wear.	--	Replace shaft assembly.
(8) Internal splines.	0.007 inch maximum wear.	--	Replace shaft assembly.

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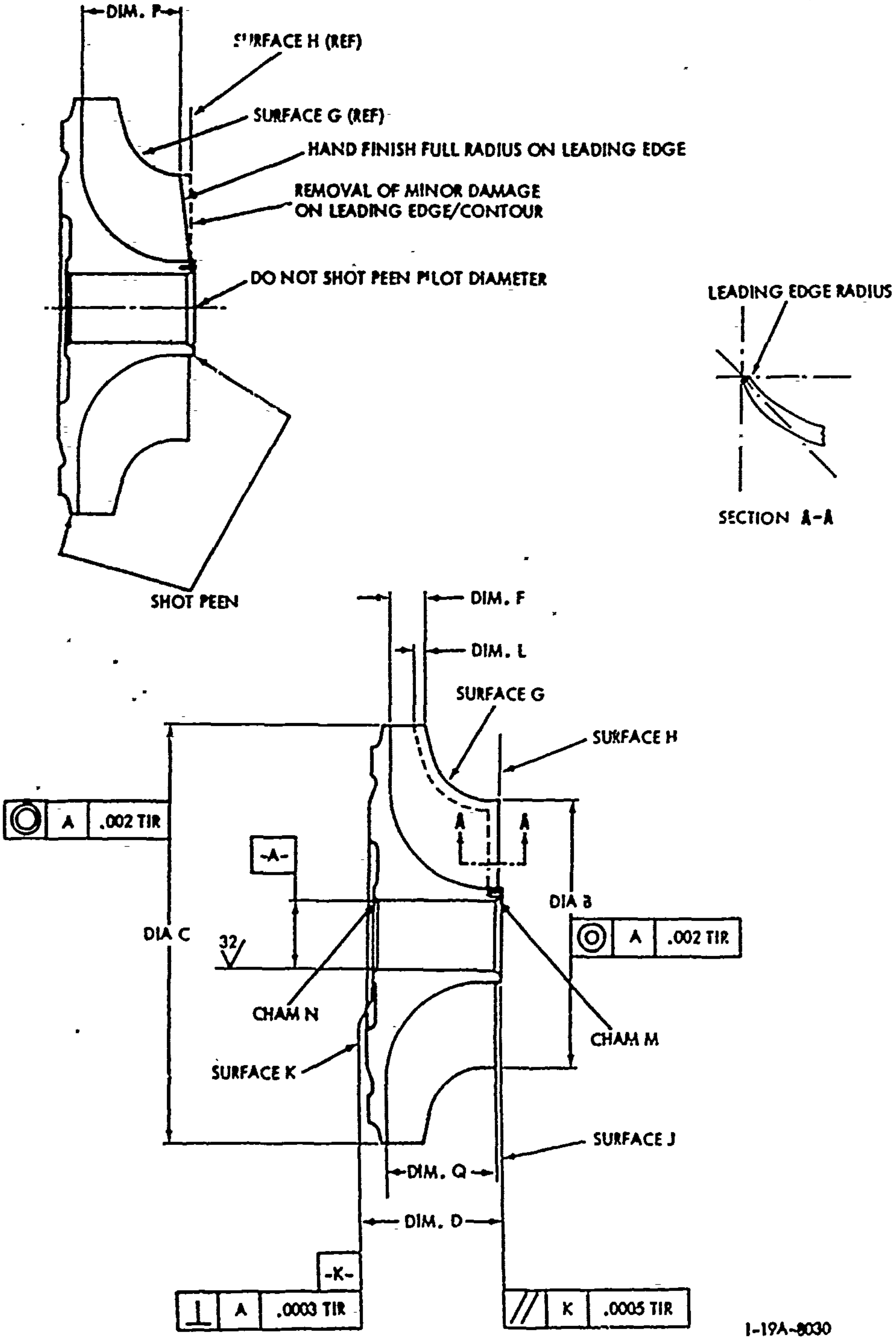

Figure 1. Second Stage Compressor Impeller (Impeller) - Repair

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Dimensional Limits for Figure 1

DIA A	1.1570 to 1.1572 inches	CHAM M	40 to 50 degrees by 0.045 to 0.55 inch
DIA B	4.351 to 4.357 inches	CHAM N	40 to 50 degrees by 0.040 to 0.060 inch
DIA C	6.595 to 6.605 inches	DIM. P	1.736 inches minimum
DIM. D	1.972 to 1.982 inches	DIM. Q	1.771 to 1.781 inches
DIM. F	0.649 to 0.659 inch		
DIM. L	0.025 inch maximum		

(2) Repair damage to leading edge, surface H greater than 0.010 inch but less than 0.035 inch.

(a) Machine or grind surface H to remove damage maintaining limits of dimension P.

(b) Finish leading edge, surface H, to a 4:1 elipse, true within 3.5:1 to 4.5:1, centered on blade contour with minor axis equal to the blade thickness.

(c) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(d) Corrosion treat reworked area in accordance with WP 003 00.

(e) Balance in accordance with step d.

(3) Weld repair contour or leading edge damage greater than 0.035 inch but less than limits of dimension L.

(a) Removing the minimum amount of base material to clean up defects, machine or grind surfaces G and/or H within limits of dimension L.

(b) Weld surfaces G and/or H in accordance with T.O. 1-1A-9 and T.O. 34W4-1-5 using weld rod (53-78).

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(c) Machine or grind surfaces G and/or H maintaining original contour and specified limits of dimension Q and diameter C.

(d) Finish leading edge, surface H to a 4:1 elipse, true within 3.5:1 to 4.5:1, centered on blade contour with minor axis equal to blade thickness.

(e) Hand finish to remove excess weld. Welds shall blend smoothly with existing blade surfaces including leading edge radius.

(f) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(g) Balance in accordance with step d.

(h) [redacted]

(i) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(j) Shot peen repaired area as specified in accordance with MIL-S-13165 using steel shot (53-101) to achieve intensity 0.004 to 0.006 Almen A2 in designated areas. Resultant shot peen flash is permissible

(4) Grind contour of impeller blades using table of coordinates in figure FO-1, balance in accordance with step d.

(5) Corrosion treat reworked area in accordance with WP 003 00.

b. Repair Diameter A.

(1) Machine or grind diameter A, not to exceed 1.177 inches maximum.

(2) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

CAUTION

No overspray allowed on surfaces J and K.

(3) Plasma spray in accordance with T.O. 2-1-111 to a minimum diameter to 0.153 inch using metal spray (53-98).

(4) Machine or grind diameter A maintaining specified limits.

(5) Machine or grind surfaces J and K maintaining limits of dimension D, perpendicularity and parallelism.

(6) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(7) Corrosion treat reworked area in accordance with WP 003 00.

(8) Balance in accordance with step d.

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c. Repair Surfaces J and K.

(1) Machine or grind surfaces J and K maintaining limits of dimension D, perpendicularity and parallelism.

(2) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(3) Corrosion treat reworked area in accordance with WP 003 00.

(4) Balance in accordance with step d.

d. Balance. (See figure 2.)

NOTE

Tools called out in the following procedure are for use on a standard 1S or 13S Gisholt balancing machine.

(1) Balance in accordance with WP 003 00, paragraph 7s.

(2) Install impeller on 281128 mandrel and using two 256377-7 inserts, place on balancing machine.

(3) Using 284383-1-1 drive assembly or belt drive, direct air on the impeller blades.

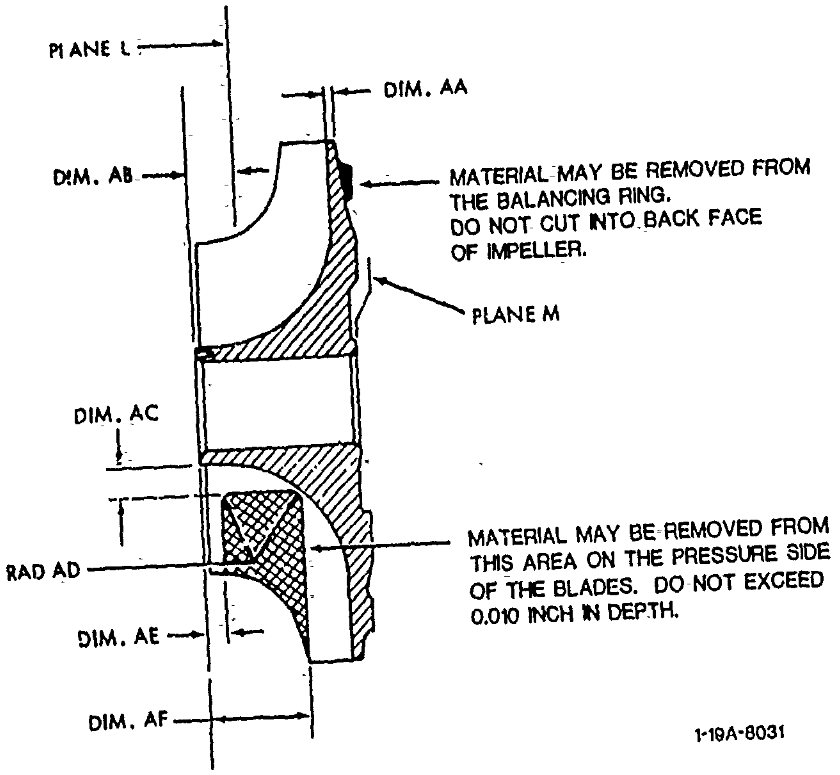
(4) [redacted]

(5) Remove material, if required, within specified limits to obtain balance accuracy. Blend all reworked surfaces smoothly to 80 microinches finish or better. Cut sharp corners or edges to radius of 0.015 inch or greater.

(6) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(7) Corrosion treat reworked area in accordance with WP 003 00.

(8) Package in accordance with MIL-P-116 to prevent damage.



MATERIAL MAY BE REMOVED FROM THE BALANCING RING. DO NOT CUT INTO BACK FACE OF IMPELLER.

MATERIAL MAY BE REMOVED FROM THIS AREA ON THE PRESSURE SIDE OF THE BLADES. DO NOT EXCEED 0.010 INCH IN DEPTH.

DIM. AA 0.085 inch minimum
DIM. AB 0.60 inch basic
DIM. AC 0.32 inch minimum
RAD AD 0.30 inch minimum
DIM. AE 0.13 inch minimum
DIM. AF 1.147 inches maximum

Figure 2. Second Stage Compressor Impeller (Impeller) - Balance

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e. Repair Surfaces F and K. (See figure 1.)

(1) Machine or grind surfaces F and K maintaining limits of dimension E.

(2) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(3) Corrosion treat reworked area in accordance with WP 003 00.

(4) Balance in accordance with step f.

f. Balance. (See figure 2.)

NOTE

Tools called out in the following procedure are for use on a standard 1S or 13S Gisholt balancing machine.

(1) Balance in accordance with WP 003 00, paragraph 7s.

(2) Install impeller on 281892-1-1 arbor, torque nut to 50 inch-pounds and place in balancing machine.

(3) Direct air on the impeller blades using 284383-1-1 drive assembly or belt drive.

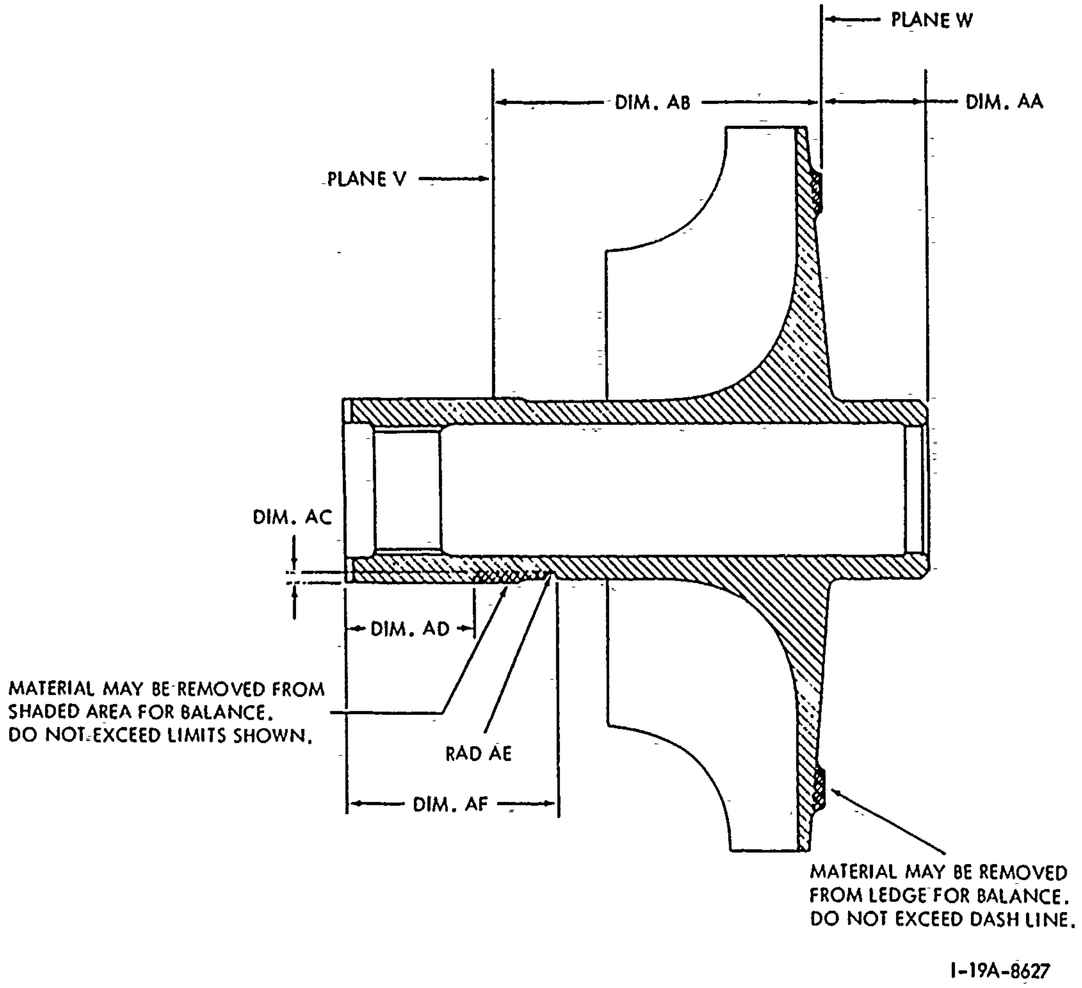
(4) Balance shall be within 0.004 ounce-inch in planes V and W.

(5) Remove material, if required, within specified limits to obtain balance accuracy. Blend surface to 63 microinches finish or better. Break sharp edges to 0.015 inches radius or greater.

(6) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

(7) Corrosion treat reworked area in accordance with WP 003 00.

(8) Package in accordance with MIL-P-116 to prevent damage.


PLANE W
DIM. AB
DIM. AA
PLANE V
DIM. AC
DIM. AD
MATERIAL MAY BE REMOVED FROM SHADED AREA FOR BALANCE. DO NOT EXCEED LIMITS SHOWN.
RAD AE
DIM. AF
MATERIAL MAY BE REMOVED FROM LEDGE FOR BALANCE. DO NOT EXCEED DASH LINE.
I-19A-8627

DIM. AA	0.88 inch minimum	DIM. AD	1.20 inches minimum
DIM. AB	3.00 inches minimum	RAD AE	0.05 inch minimum
DIM. AC	0.07 inch maximum	DIM. AF	2.00 inches maximum

Figure 2. Second Stage Compressor Impeller (Impeller) - Balance

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(2) Repair bent blade tips.

  (a) Use a suitable device to straighten bent wheel blades.

  (b) Inspect wheel blade for a bend line. No bend lines are permitted.

  (c) Perform non-destructive inspection of reworked area in accordance with T.0. 33B-1-1.

  (d) Apply corrosion preventative compound (43-30A) to reworked area.

  (e) Balance in accordance with step j.

i. Repair Wheel Contour Damage. (See figures 1 and 3.)

(1) Machine or grind damage on surface G maintaining specified limits and table of coordinates. Surface G shall have a finish of 63 microinches or better.

(2) Hand finish edges to blend into existing surfaces maintaining limits of radius BF.

(3) Perform non-destructive inspection of reworked area in accordance with T.0. 33B-1-1.

(4) Mask gap between wheel and exducer. Shot peen reworked area in accordance with MIL-S-13165 using steel shot (43-95) to achieve intensity 0.004 to 0.006 Almen A2.

(5) Remove masking and masking residue from between wheel and exducer.

(6) Apply corrosion preventative compound (43-30A) to reworked area.

(7) Balance in accordance with step j.

j. Balance Wheel and Shaft Assembly. (See figure 4.)

NOTE

Tools called out in the following procedures are for use on a standard 1S or 13S Gisholt balancing machine.

(1) Balance in accordance with WP 003 00, paragraph 7s.

(2) Using 281889-1-1 cradle, mount wheel and shaft assembly in balance machine.

(3) Balance shall be accurate within 0.046 ounce-inch in plane X and 0.014 ounce-inch in plane W.

(4) Material may be removed to obtain balance in the following procedures.

  (a) Material may be removed from surface Y maintaining limits of diameter CA and dimention CB. Blend surface to 63 microinches finish or better. Break sharp edges to 0.015 inch radius or greater.

  (b) Material may be removed from surface Z to obtain balance. Blend surface to 63 microinches finish or better. Break sharp edges to 0.015 inches radius or greater.

  (c) Perform non-destructive inspection of reworked area in accordance with T.O. 33B-1-1.

  (d) Apply corrosion preventative compound (43-30A) to reworked area.

(5) Package in accordance with MIL-P-116 to prevent damage.

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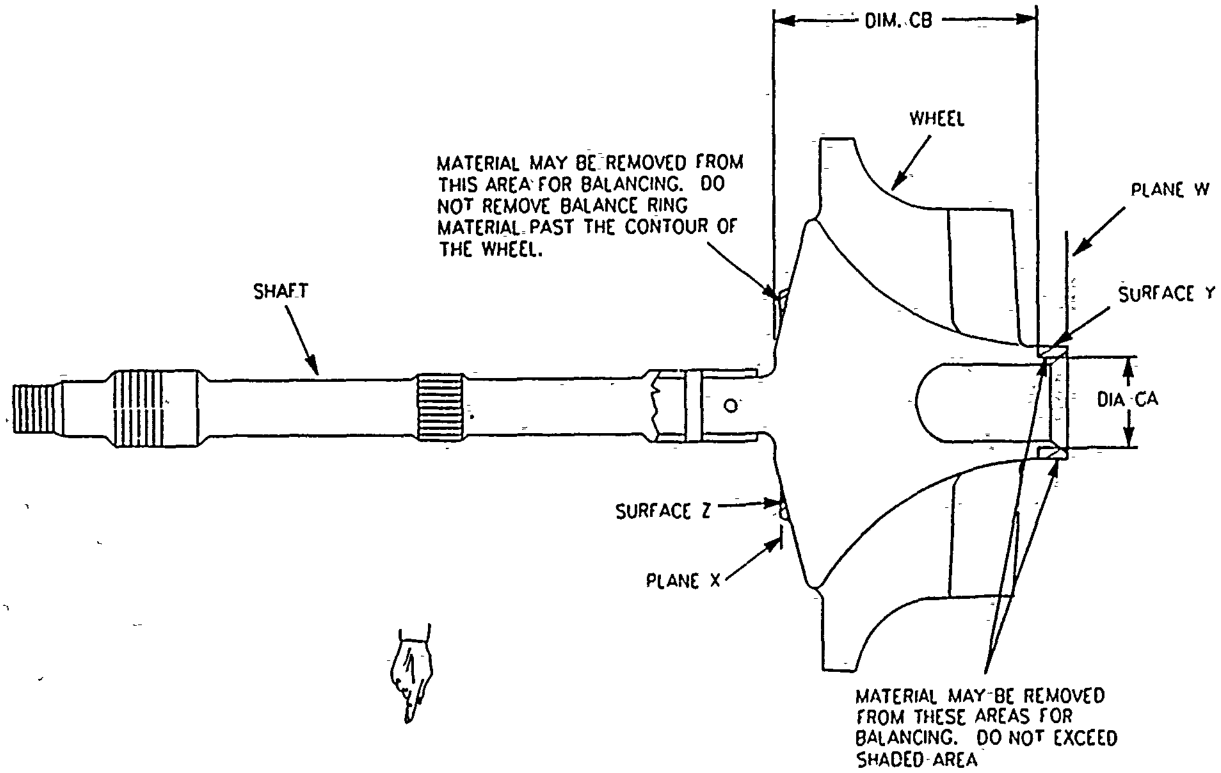

DIM. CB
WHEEL
MATERIAL MAY BE REMOVED FROM THIS AREA FOR BALANCING. DO NOT REMOVE BALANCE RING MATERIAL PAST THE CONTOUR OF THE WHEEL.
PLANE W
SHAFT
SURFACE Y
DIA CA
SURFACE Z
PLANE X
MATERIAL MAY BE REMOVED FROM THESE AREAS FOR BALANCING. DO NOT EXCEED SHADED AREA

DIA CA 1.600 INCHES MIN
DIM CB 4.580 INCHES MIN

1-19A-8689

Figure 4. Turbine Wheel and Shaft Assembly (Wheel and Shaft Assembly) - Balancing Repair

IDENTRONIX, Inc.
1718 Soquel Avenue
Santa Cruz, CA 95062

IDX™
IDENTRONIX

The Leader in Radio Frequency Identification Systems

MODEL 2311
SYSTEM

IDX MODEL 2311 SYSTEM

Solutions for the most challenging automatic identification problems.

SYSTEM FEATURES

☐ An automatic identification system for the harshest industrial environments.

☐ Reliable performance even when ID Tags are obscured by non-conductive material such as dirt, grease, mud, plastic and paint

☐ Totally passive Tag that requires no on-board power, batteries or external electrical connections.

SYSTEM DESCRIPTION

The IDX Model 2311 System incorporates a compact, passive identification Tag and a micro processor-based Reader with Antenna. The system is designed to provide reliable identification of raw materials, work-in-process and finished goods in a wide variety of factory and distribution applications.

IDX Tags contain a proprietary CMOS chip that is factory programmed or field programed with up to 20 characters. Depending on the application, the Tags are packaged in high impact polycarbonate or high temperature thermoplastics. The Tags are designed to provide years of reliable service in the most demanding industrial environments. They are ideally suited for identifying high unit value products and can be permanently attached to such captive product carriers as tote boxes, pallets, containers and trolleys.

The Model 2311 Reader is a solid state device designed for installation on the factory floor or outdoors in the toughest environments. Through a cable linked antenna, the Model 2311 captures, decodes and validates Tag data content for subsequent transmission to a programmable controller or host computer.

The Model 2311 Readers transmit UHF signals to their Antenna. These signals activate IDX Tags moving through the Antenna's field of view. The Tags then respond with a unique coded signal that is transferred to the Reader for processing. Once decoded and validated, Tag data content is transmitted to the host via an industry standard RS232C communications interface.

The Model 2311 System offers the leading state-of-the-art solution to industrial automatic identification problems not easily handled by optical, magnetic or other radio frequency techniques.

SYSTEM OPERATING PARAMETERS

Capture Window.

The "capture window" is the portion of the conically shaped UHF field generated by the Model 2311 Reader/Antenna in which an IDX Tag can be read. Transmit power and distance (range) from the Antenna to the Tag determine its effective area. The greater the range, the larger the window. During applications analysis, the desired dimensions of the "capture window" must be precisely defined.

Tag Speed

The Model 2311 System requires several successive identical responses from a given Tag prior to validation and transmission to the host computer. The number of responses that can be obtained from a Tag depends upon the size of the "capture window" and the speed at which the Tag moves through that "window." For example, at a range of one (1) foot, the Model 2311 System will reliably handle Tag speeds of up to [illegible] feet per minute. At a range of two (2) feet, the System will accommodate speeds of up to 180 feet per minute. The IDX transportation systems are capable of reliably identifying Tags moving at speeds in excess [illegible] 120 miles per hour.

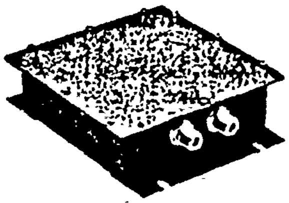
Tag Orientation/Spacing

For optimum performance, IDX Tags should be mounted in parallel with the Model 3300 Antenna. At limited ranges and correspondingly smaller "capture windows", alignment should be within +/- 15 degrees to ensure a maximum number of responses from the Tag as it passes by the Antenna. Alignment becomes less critical as range increases. Typically, Tag spacing should be twice the distance between the Antenna and the Tag; for example, at a range of one foot, Tags should be spaced at least two feet apart as they pass the Antenna location.

MODEL
2311
READER

Dimensions	24"H X 19"W X 10"D
Weight	76 Lbs
Housing	NEMA TYPE 12
Operating Temp	0c +60c
Power Requirements	120 Volts,50/60Hz 1.5 Amp
RF Characteristics	Transmit 915 Mhz Receive 1830 Mhz
Communications Interface	Serial ASC11, RS232, 422 or 20 mA Current Loop.

The 2311 Reader is designed to operate in the most rigorous environments where optical scanning does not work or is not dependable.

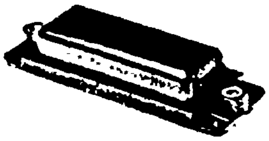


MODEL
3300
ANTENNA

Dimensions	8"H x 7"W x 2"D
Weight	1.5 Lbs
Housing	Nema Type 12
Operating Temp	-40c to +70C

The Model 3300 Antenna can be used in a number of transportation and industrial applications. The Antenna is compact, simple in design and geared for the toughest identification requirement.

TYPE A
4006 TRANSPORTATION
TAG



Dimensions	8.25"H x [illegible] x 1.5"L
Weight	6.8 [illegible]
Enclosure	High Impact Polycarbonate
Operating Temperature	-40C to + [illegible]
Electrical	Totally Passive
Data Capacity	Up to 20 Characters.
Range Antenna/Tag	Up to [illegible]
Speed	Up to 125 Miles per Hour.

Built of high impact polycarbonate, the Transportation Tag thrives in the toughest environments, as confirmed by U.S. Government sponsored tests. These independent studies show near perfect performance under harsh conditions at speeds in excess of 120 MPH.

TYPE "H"
4300 HIGH
TEMPERATURE TAG

Dimensions	7"H x 2.25"W x .5"D
Weight	1.5 Oz
Enclosure	Ultem High temp plastic
Operating Temperature	-40C to +70C 158°F
Storage Temp Range	Up to 200C
Electrical	Passive. No internal Power
Data Capacity	20 Alpha Numeric Characters

Using Ultem Plastic as the printed circuit board substrate, the High Temperature Tag can withstand temperatures up to 200 degrees C. Applications include paint ovens, batch processing and jobs where optical labels would disintegrate.

→ 392°F

IDENTRONIX, Inc.
1718 Soquel Avenue ☐ Santa Cruz, CA 95062
408/427-[illegible]248 ☐ Telex 351434

READ/WRITE SYSTEMS 9300 SERIES.

FEATURES

☐ Read/Write capability

☐ Long Range, no touch sensing (up to 3 feet)

☐ Hardened design for tough industrial environments.

☐ Interfaces with programmable controllers and computers.

DESCRIPTION

The IDX Read/Write System is a microprocessor controlled RF identification system. It possesses the capability of bi-directional remote data transfer and storage to an ID Tag. This System allows real-time updating of process information such as material assembly, task completion, quality control test results and additional data as a specific article moves through a manufacturing or assembly operation.

OPERATION

In operation, the IDX Read/Write System emits a low-power UHF pulse signal that energizes the Tag. A coded command block is sent by the controller containing the operation to be performed (read or write), the starting address, and the block size. The Tag responds with an encoded status byte containing memory integrity information and other diagnostics. The controller then sends the data to be written, in the case of a write command, or receives the data being sent by the reader, in the case of a read. The tags hold up to 2K bytes of data and can be programmed at ranges up to 3 feet.

EQUIPMENT OVERVIEW

Controller: The microprocessor-based controller sends and receives high frequency, low-power signals to the Antenna. The controller is designed to connect to either a host or programmable controller (PC).

Antenna: The dipole Antenna is attached to the Controller via low loss cable. It contains both the transmit and receive antennas etched on one printed circuit board. The antenna can be mounted either below, along side or above the path that the Tags travel.

Tag: This small, battery powered device stores up to 2K bytes of data. The Read/Write tag is activated when it enters the antenna's RF field at which time information can be read from or written into the memory.

ABOUT THE COMPANY

IDX is the recognized leader in Radio Frequency Identification Systems. Based in Santa Cruz, California, IDX specializes in providing reliable and dependable solutions to automatic identification problems not readily addressed by optical, magnetic or other radio frequency methods.

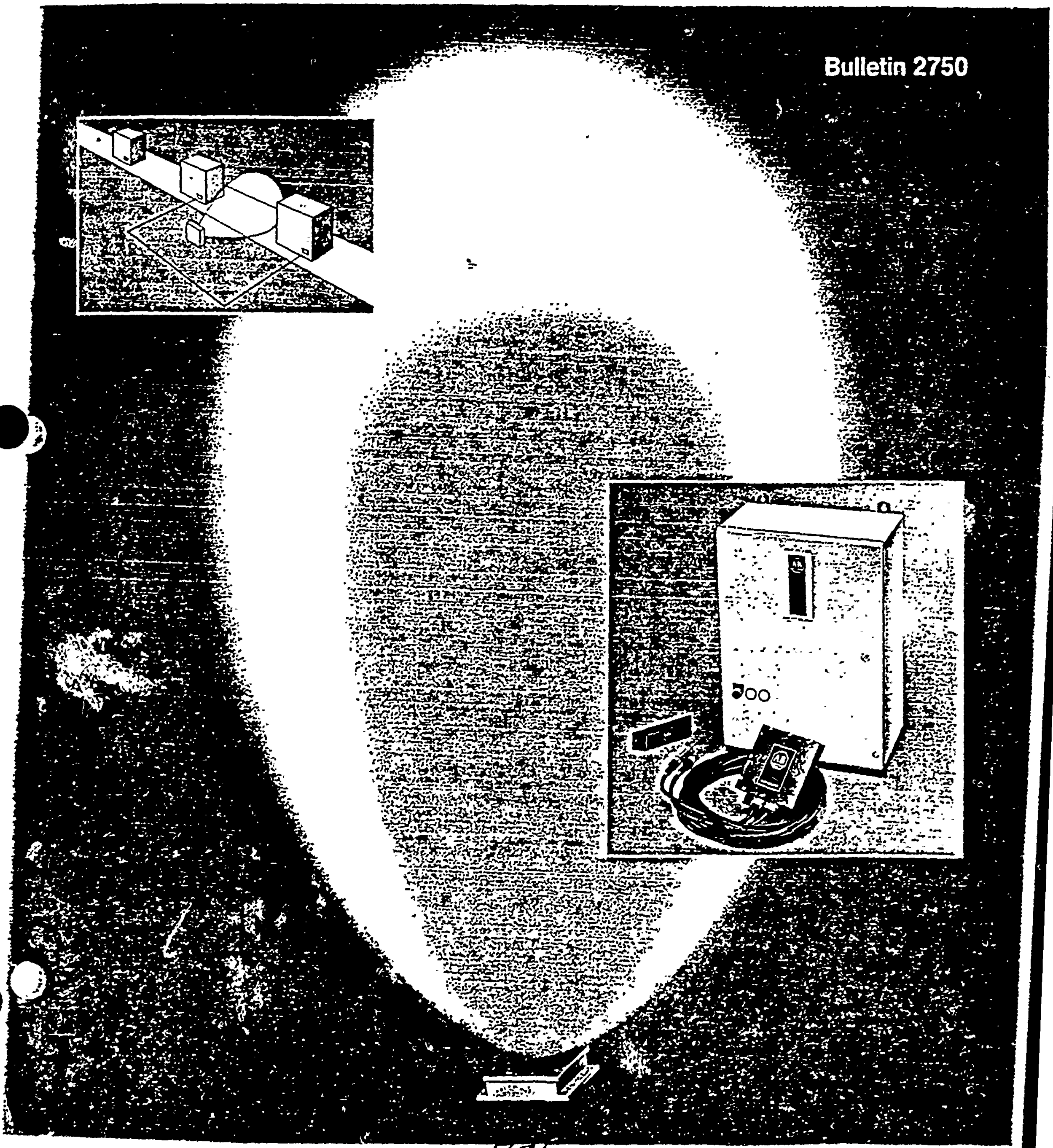
The IDX Tag, Reader and Antenna are designed to withstand extremely difficult industrial environmental conditions. The company is dedicated to providing quality products geared for the toughest identification challenges.

IDENTRONIX, Inc.
1718 Soquel Avenue ☐ Santa Cruz, CA 95062
408/427-2248 ☐ Telex 351434

Allen-Bradley

RF Identification System

Bulletin 2750



A Unique RF System Featuring A Totally Passive Tag...

- Long range remote identification (up to five feet)
- Real time and accurate information
- Flexible interface to programmable controllers and computers
- Self-diagnostic capabilities

DESCRIPTION

The Radio Frequency (RF) Identification system is designed for Automated operation. It is used to automatically identify, monitor, verify and control material flow.

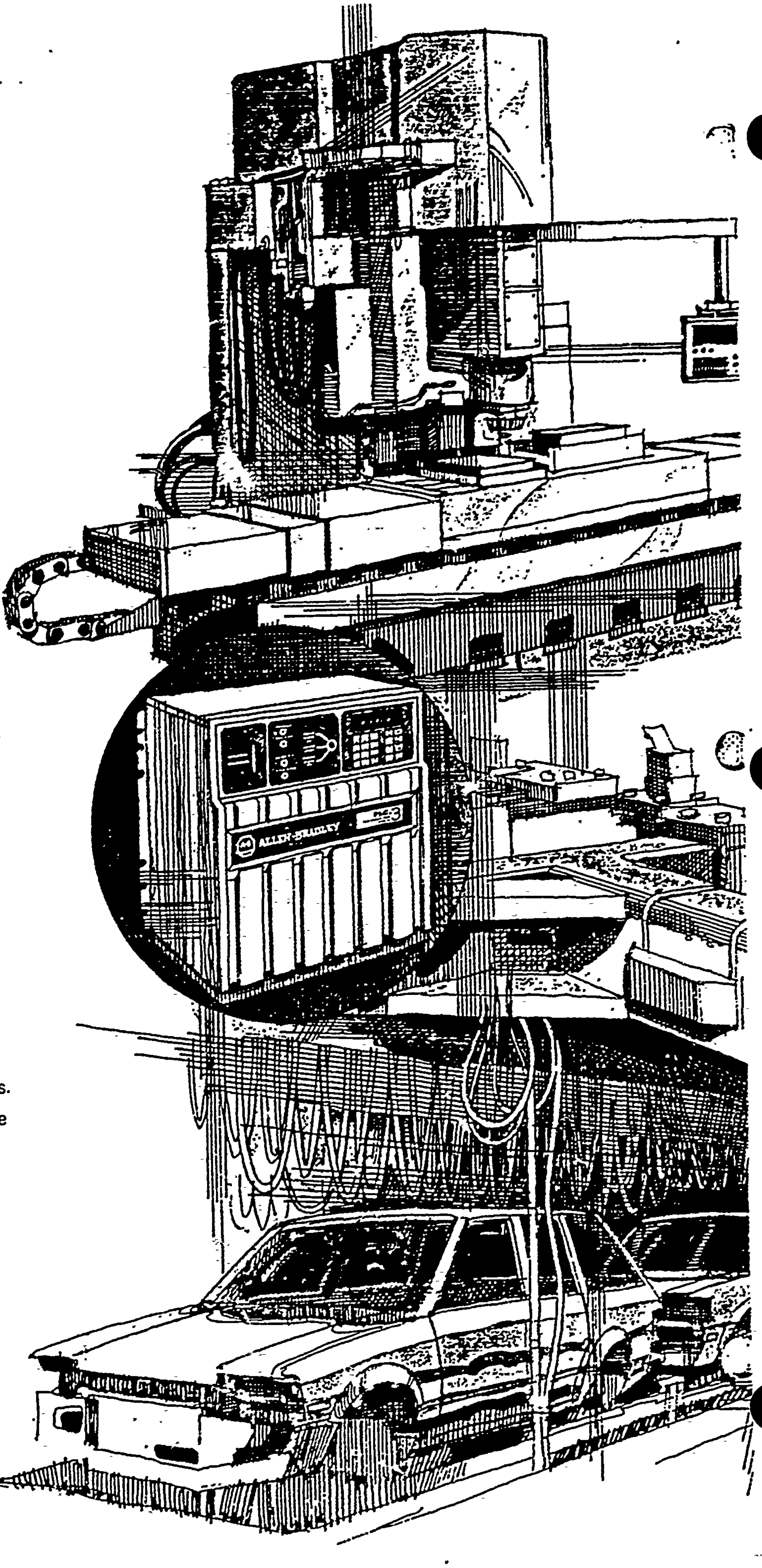
The RF system is designed for industrial factories, warehouses, distribution centers and foundries. It uniquely identifies remote products at distances up to five feet away and can survive in high temperature environments. It is virtually unaffected by contaminating materials such as dirt, paint, dust, grease and other non-conductive materials. ✓ on this

This system's communications interface to host computers, programmable controllers and intelligent terminals. It provides input for management reporting as well as on-line control of tagged item movement.

Reader—The microprocessor-based reader transmits and receives high frequency low power signals from the antenna. It decodes and verifies tag data content and transmits it to the host computer.

Antenna—The antenna contains both the transmit and receive antennae and connects to the reader via coaxial cables.

Tag—The ID tag is a totally passive device that powers itself from the antenna's RF energy. It is factory programmed with a six digit code.



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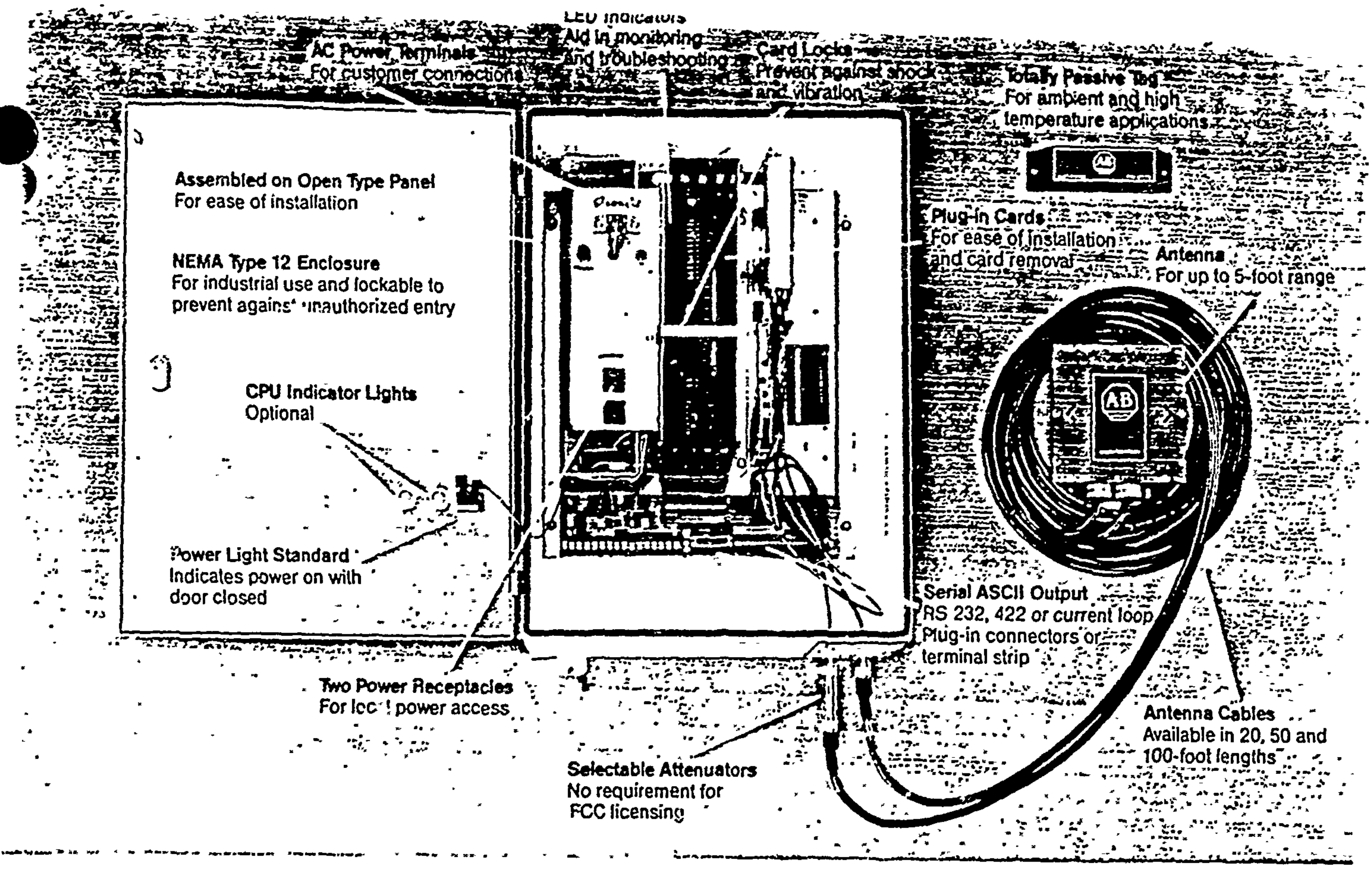
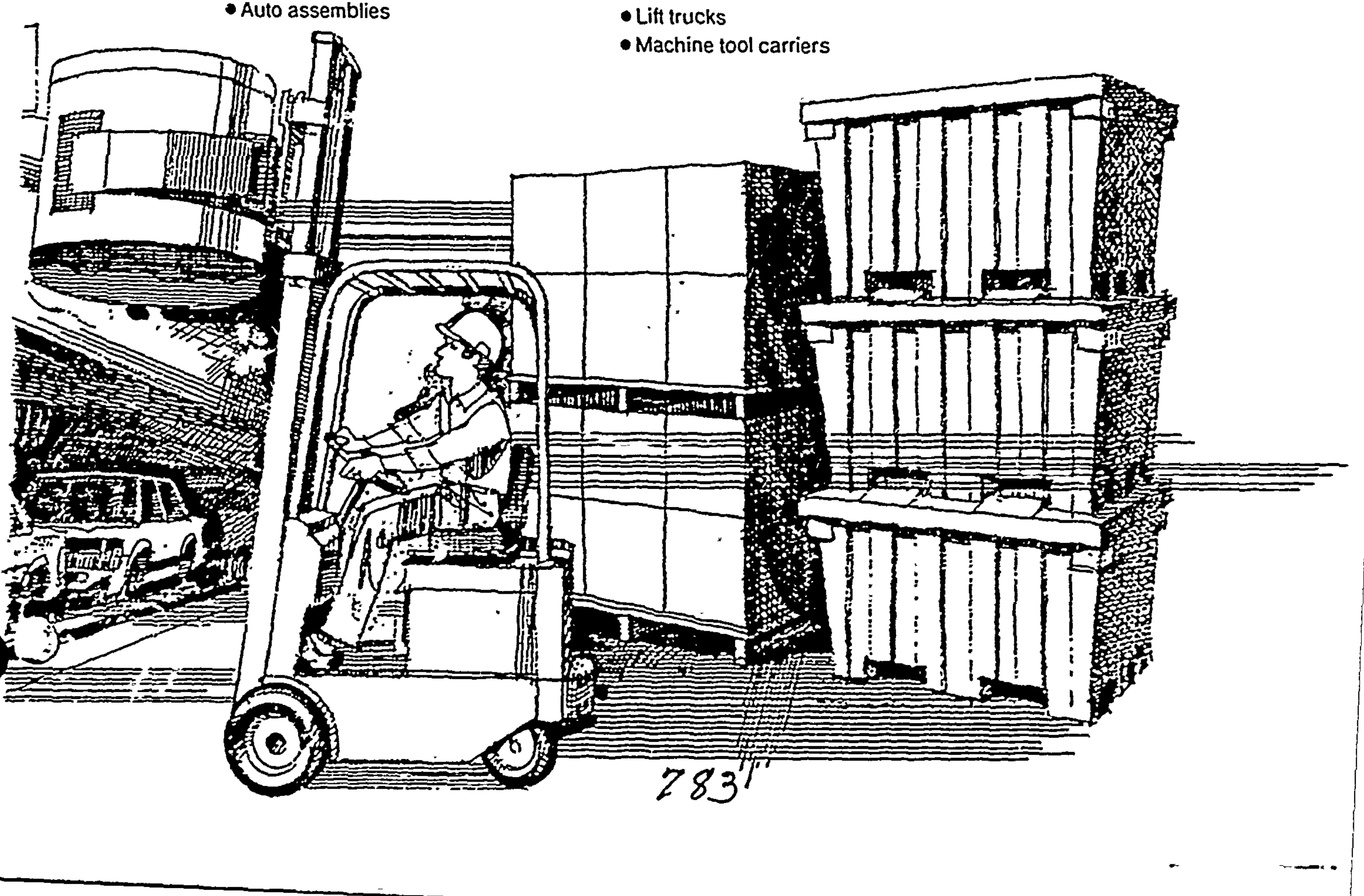


APPLICATION

The RF System is ideally suited for identification of industrial products or carriers such as:

- Auto assemblies
- Tote boxes
- Containers
- Pallets
- Trolleys
- Lift trucks
- Machine tool carriers

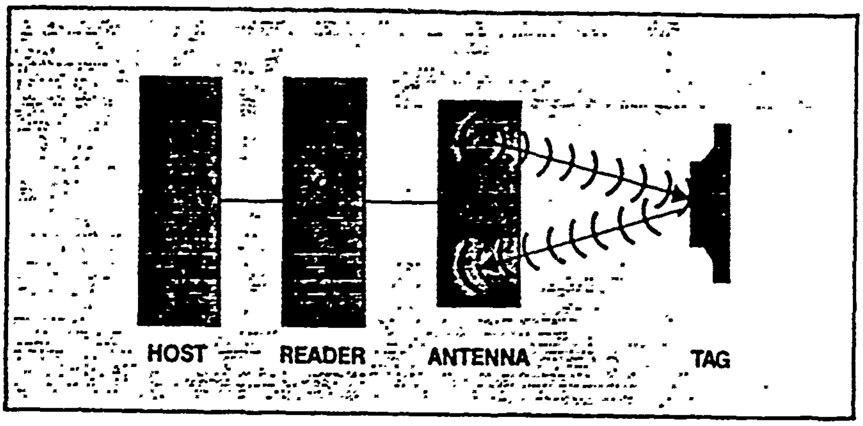
The system provides reliable tracking throughout the manufacturing, assembly or distribution process.



OPERATION

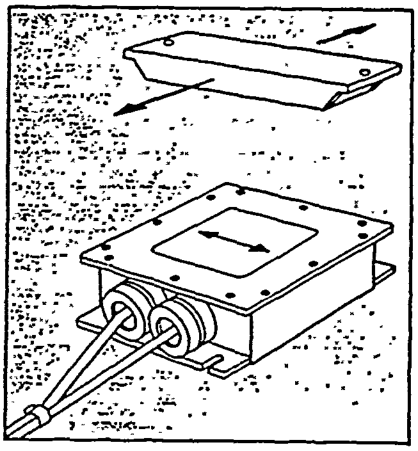
When a tagged object enters the radio frequency (RF) field generated by the reader and its antenna, the tag is interrogated and its circuitry is activated. It transmits a programmed six-digit code that is read by the microprocessor-based reader. The reader decodes this information and sends an output to a host computer, logging device or programmable controller for the appropriate action, response or recording.

In addition, the reader provides information for system analysis and troubleshooting. The message format includes location, time, and other diagnostics information.



TAG ORIENTATION

For optimum performance, tags should be traveling perpendicular to the arrows on the face of the antenna. The long axis of the tag should be parallel to the arrows on the face of the antenna.



SPECIFICATIONS

Description	Specification
READER	
Power Requirements:	120 Volts, 50/60 Hz 1.5 Amperes
Operating Temperature:	0°C to +60°C
Output:	Serial ASCII RS 232, 422 or 20mA current loop
Baud rate:	110 to 19,200 selectable
Enclosure:	NEMA Type 12
Approximate Weight:	76 lbs.
Approximate Dimensions:	24"Hx18"Wx10"D
ANTENNA	
Transmit Frequency:	915 MHz
Receive Frequency:	1830 MHz
Operating Temperature:	-40°C to +60°C
Approximate Weight:	1.5 lbs.
Approximate Dimensions:	8"Hx7"Wx2"D
Attenuator (Separate):	Refer to selection guide
Cables (Two required):	20, 50, or 100-ft. length
TAG	
Power:	Passive
Range:	5-feet maximum
Temperature:	
Operating	-40°C to +70°C
Non-operating	-40°C to +85°C (Extended temperature ranges available) 185°F
Available Codes:	6-Digits (000001-999999)
Approximate Weight:	3.5 oz.
Approximate Dimensions:	2"Hx7.5"Wx1"D

Extended Temperature up to 392°F

ALLEN-BRADLEY

Publication 2750-1.0--February, 1984
Supersedes Publication 2750-1.0 Dated April, 1983

ENGINEERING NOTES

EMPLOYEE [illegible] DATE ______ PAGE NO. 1

RCC NATPGB SUBJECT [illegible]

Following is a rough calculation of the distribution of vibration rejections for the 3[illegible] and 377 GTE's. The data was obtained from a data base supplied by Brent Castle.

FY	Cause of vibration (all GTE's)			TOTAL
	acc-case	turbine	compressor	
86	32	36	22	90
87	1	7	11	19
88	19	19	40	78
89	11	19	43	73
TOTAL	63	81	116	260

accessory-case : 63/260 = 24%

turbine : 81/260 = 31%

compressor : 116/260 = 45%

31+45 = 76% of the [illegible] are caused by [illegible]

These numbers are rough, but they can be used to draw some general conclusions about the relative distribution of the causes. It can be seen that problems have existed for all three major sections of the engine. Vibration problems are not limited to just one component of the engine. However, 76% of vibration problems [illegible] the compressor and turbine sections. There must be many different causes for the rejections. [illegible] different

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RCC [illegible] PGP SUBJECT VIBRATION

engine types it is unlikely for all vibration problems to be caused by design flaws in the compressors or turbines. For example, the 180-type engines have the compressor impellers and turbine wheel mounted on the same shaft, whereas the 397-type engines have compressor impellers and turbine wheel mounted on seperate shafts. However, vibration problems occur for both types of compressors and turbines. At this point it is difficult to determine whether the vibrations are caused by seperate problems unique to each different component or are caused by common problems such as balancing quality or assembly quality and technique.

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ENGINEERING NOTES

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PAGE NO.
RCC MATPGB
SUBJECT Balancing technique

Balance technique

Currently MATPGB is using a two-plane rigid rotor balancing method for the compressor and turbine rotors. Balancing speed is 800 RPM. The two-plane method is valid for any rotor which can be considered rigid. The 180 and 397 compressor shafts are considered to be rigid. This is likely to be true considering the short length and high stiffness of [illegible] shafts. The balancing machines are essentially automatic, requiring no figuring by the operator. Unbalance magnitude and orientation are displayed by the equipment for each balance plane. The balance machine operator uses a trial and error method of metal removal (grinding) to bring the rotor into balance limits as outlined by the current TOs. As a general rule the operators try to balance the GTE components beyond the levels required by the TOs. Often they are able to balance the rotors and components to the limits of the balance machine sensitivity. According to Bill Hunt (supervisor) the indicated position vector of the residual unbalance begins to "wander" when unbalance approaches .001 oz·in. It is doubtful that balance quality can be improved [illegible] this point with the current equipment and balancing speed. Increased sensitivity might be attained by increasing the rotation [illegible] of the rotor being balanced.

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ENGINEERING NOTES

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RCC MATPGB SUBJECT Balancing speed

It might be possible to increase the sensitivity of current balancing machines by increasing the balancing speed. Following are rough calculations as to the approximate increase in pulley size that would be required.

The force exerted by a rotating mass (M) with a unbalance is given by:

$$f = Me\omega^2$$

where ω is in radians/sec and e is the distance from the axis of rotation and the center of mass. Hense, radial force is proportional to the square of rotational speed.

$$f \propto \omega^2$$

Since radial force is the measured quantity of the balancing machine, increasing it would increase sensitivity. Force at the balance machine sensors would be doubled using the following increase in pulley size.

$$F_2 = 2F_1 \Rightarrow \omega_2^2 = 2\omega_1^2 \Rightarrow \omega_2 = \sqrt{2}\,\omega_1 = \underline{1.41\,\omega_1}$$

Since circumference $C = \pi D \Rightarrow C \propto D$ D = diameter and motor rotational speed is constant, rotational speed of the rotor will vary proportionally with pulley diameter. Thus, $D_2 = \sqrt{2}\, D_1$. More generally, pulley diameter must be increased by a factor approximated by the square root of the [illegible] of the increased radial force needed in order

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ENGINEERING NOTES

EMPLOYEE Premo
DATE
PAGE NO. 2
RCC MAT PGB
SUBJECT [illegible] speed

to obtain the improved sensor sensitivity.

$$D_2 \approx \sqrt{\text{Force increase mag}}\ D_1$$

For example if radial force at the sensor had to be increased by say 20% to reach the desired sensitivity level. the rough drive pulley size increase could be calculated as follows:

$$D_2 = \sqrt{1.2}\ D_1 = 1.0954\ D_1$$

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RCC MATDGB SUBJECT BALANCE QUALITY GRADE

Following is a discussion of balance quality grade and current balancing criteria as specified by current TO's (Tech Orders).

Because there are so many different factors that effect the overall vibration level of a turbo-machine it is difficult to choose a suitable balance criterion. Bearing alignment, fit, and dissymmetries, or aerodynamic effect, or machining errors are just a few of the potential causes of vibration other than simple rotor unbalance. Also, there is no simple relationship between rotor unbalance and vibration level because of the damping effect of the bearing supports and structure. Hense, perfect balance of a rotating component doesn't guarantee no vibration and measurement of a vibration level cannot be easily used to figure the degree of rotor balancing that is required to prevent vibration. For this reason, the ISO (International Standards Organization) has developed a classification system for various types of rotors. The standard is based upon the compilation of years of data gathered on acceptable balance criteria for the the different types of rotors. According to ISO standard 1940-1973, "Balance Quality of Rotating Rigid Bodies" the following balance quality was developed (a copy of the ISO standard follows this discussion). There are two balance quality grades that could be used for the the rotating components. Grade G6.3 used on assembled aircraft gas-turbine rotors and

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RCC MATPGB SUBJECT BALANCE QUALITY GRADES

grade G2.5 applies to gas and steam turbines, rigid turbo-generator rotors, rotors, and turbo-compressors. Of the two standards the G2.5 is more demanding. Based upon an operating speed of 40,000 RPM, G6.3 calls for a [illegible] acceptable residual unbalance of .00004 lb·in per lb of rotor weight and G2.5 specifies .000015 lb·in per lb of rotor weight. The acceptable residual unbalance for the GTE's [illegible] is probably somewhere between these two values. For the purposes of the following comparison with current T.O. balance criteria the less demanding standard (G6.3) was used.

The comparison follows this page. For the analysis the approximate weights for the [illegible] 130 and 397 rotating components were measured using a scale. It should be noted that the weights are approximate and the resulting residual unbalance calculations are rough estimates for the purposes of comparison only. Because the ISO residual unbalance numbers that were calculated are for the sum of both balancing planes (2 plane balancing system), the numbers were divided in the same proportion as for the balance planes specified in the balance T.O.s.

Without exception, the ISO limits were more rigid than those specified in the current T.O.s, ranging from 1.5 to 7.1 times more stringent. Many of the suggested residual unbalance limits (ISO standard [illegible]) are right at the limit of the current balancing machines sensitivity level [illegible] of [illegible] local.

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ENGINEERING NOTES

EMPLOYEE Premo DATE PAGE NO. 3

RCC MATPGB SUBJECT Balance quality grade.

vector for the unbalance begins to float;
If balance quality grade G2.5 is selected current balance machines are not sufficiently sensitive to obtain the needed balance quality.

Summary:

. Using the ISO criteria the current balancing specifications are not sufficiently rigid to obtain the needed balance quality. In addition, the current balance machines may not have the necessary sensitivity to reach the ISO specifications without modification. Changing the balancing speed may be possible using a larger drive pulley on the balancing machine..

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EMPLOYEE [illegible] DATE 11-15-90 PAGE NO. 1

RCC [illegible]PSB SUBJECT Comparison of ISO vs TO balance criteria

ITEM	weight (lbs)	ISO std total unbalance	Residual unbalance				
			[illegible] plane		other plane		
			TO	ISO	TO	ISO	TO/ISO
Turbine wheel+shaft 180	16	.0102	.046	.008	.014	.002	5.9
1st stage impeller '80	4.8	.0031	.007	.0016	.007	.0016	4.5
2nd stage impeller '80	3.2	.0020	.004	.001	.004	.001	4
Turbine wheel 397	13	.0083	.010	.004	.010	.004	[illegible]
Compressor shaft	3	.0019	.005	.001	.005	.001	5.3
3rd stage impeller	2.2	.0014	.005	.001	.005	.001	7.1
assembled CRA (with 1st stage installed)	8.2	.0052	.002	.001	.006	.004	1.5

Notes: 1) all unbalance numbers are in oz-in
2) ISO standard G2.5 numbers was obtained by multipling G6.3 number by the factor .375
3) total acceptable unbalance was calculated by multipling (weight)×(.00064 oz in/lb)

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ENGINEERING NOTES

EMPLOYEE [illegible] DATE ______ PAGE NO. ______

RCC MATPGB SUBJECT Balancing technique

Balancing Technique

Prebalancing of 397 1st stage components

The 397-type 1st stage compressor rotating assy (CRA) up of 4 main components: the shaft, and the 3 piece 1st stage impeller. Current TO's specify balance quality for all of the individual components as well as the completed assembly. Currently, individual components are not balanced prior to assembly. This is acceptable according to the present TOs. However, this method could cause some problems. Because most of the components are used and have had material removed for balancing, they are likely to be out of balance. When the CRA is assembled it is possible for the the sum of the unbalances to sum to a large amount (depending upon their relative positions) If this occurs, large amounts of metal must be removed in order to bring the CRA into balance limits. A better method might be to balance each component individually and then again after assembly. As a general rule it is better balance components individually prior to assembly. This method helps to reduce the chances of a couple unbalance that must be removed. At this time the balancing shop does not have the proper mandrels to hold the wheel and inducers for balancing. Mandrels would have to be manufactured before individual balancing can be done on the 1st stage components.

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ENGINEERING NOTES

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RCC [illegible] SUBJECT Machining tolerances

Shaft Regrind tolerances

Sometimes shafts are repaired by metal spraying and regrinding. It is very important that the finished surfaces all remain centered on the axis of rotation for the shaft. Runout must be kept to a minimum. For the 397 shafts, the splined portion of the shaft centers the impeller and must remain centered on the axis of rotation for the shaft. Run out should be closely monitored because it would cause a runout of the entire [illegible] impeller. While it is possible to balance a shaft assembly that has a mass offset (due to runout), any dissymmetries should be avoided if possible.

Impeller Fit

Another cause of vibrations in the 397 GTE has been caused by the fit of the second stage impeller to the compressor shaft. Ideally, the fit is designed to be an interference fit. However, in some cases the fits loosely to the shaft and causes some vibration. This is due to variability in the internal diameter of the impeller. Apparently the hole sizes vary so much that there are several different sized mandrels that are used by the balance shop. There is an effort currently underway to eliminate this problem by machining the internal diameter of the impeller and machining it to [illegible]. [illegible] be [illegible] in order [illegible] level of the interference fit.

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RCC SUBJECT SPC

Assembly technique

397 - shaft runout

Shaft runout is normally checked during the assembly process of the 397 CRA. Apparently, slight imperfections in the thickness of the inducers and impeller nuts are sufficient to cause a runout deflection of the shaft when the impeller nut is torqued. The current assembly method involves attempting several different positions on the shaft splines until measured shaft runout is within .0006 inches.

CRA stress relieving

According to Lenny Boy one of the major problems with the CRA's in the past has been the buildup of internal stresses during the assembly process. Mr. Boy is the Engineer in charge of the vibration problems. He feels that most of the 397 vibration problems have been solved by stress relieving the CRA prior to balancing. This is presently being done by striking the end of the assembled CRA with a large rubber mallet. In the future a vibration stress relieving will be used. Mr. Boy feels that many of the problems were caused by balancing the CRA prior to stress relieving. Then when the

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RCC MATPGB SUBJECT ______

CRA's were changed around during the engine assembly, the internal stresses are relieved. The subsequent changes in geometry were sufficient to throw off the balance of the CRA, causing a vibration rejection. By relieving the internal stresses of the CRA prior to balancing, Mr. Bau claims that the rejection rate for the 397 type GTE has been reduced from around 35% in September to 8% in October.

Cement

A cement similar to loctite is used to fix the 1st stage impeller to the [illegible] shaft of the 397-type engines. Whether or not this is really needed is still uncertain.

Bearing alignment

Bearing misalignments can cause vibration. During the stack up of the compressor sections of the GTE's, bore alignment is checked and must be within [illegible].

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ENGINEERING NOTES

EMPLOYEE D. Clemmons DATE PAGE NO.

RCC MATPAD SUBJECT SPC list

Following is a listing of some of the variables that may contribute to the vibration of the GTE's. A brief explanation of the variables follows this page.

SOME POTENTIAL VARIABLES EFFECTING VIBRATION

A. Balancing Technique
  1) balancing speed (balancing machine [illegible]
  2) balance quality grade (T.O. vs ISO.) of components
  3) prebalance of all components prior to assembly versus balancing only after subassembly (397 type compressor rotating assembly, CRA)

B. Machining Tolerances
  1) shaft regrind tolerences
    a) 30 - concentricity of bearing surfaces and turbine wheel / coincidence of mass centers and axis of rotation
    b) 397 - coincidence of splined portion of shaft and reground portions with the axis of rotation of the shaft
  2) fit of compressor impellers to shaft (example: interference fit of 397 [illegible] impeller to shaft varies causing a sloppy fit in some cases.)
  3) overall quality of machining tolerances: maintaining of all required [illegible] of the GTE (bearing [illegible], [illegible], or housings, diffuser [illegible], [illegible] important

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ENGINEERING NOTES

EMPLOYEE Frenz DATE PAGE NO. 2

RCC MATPGB SUBJECT SPC

are those tolerances related to the location and attachment of bearings and rotating components (ie: alignment))

C. Assembly technique and procedures

1) shaft runout after installation of 1st stage impeller (3rd type)
2) stress relieving procedure after installation of 1st stage impeller (3rd type)
3) use of cement to stabilize the location of 1st stage impeller (3rd type);
4) bearing alignments during assembly

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MACHINE SHOP/IN-HOUSE MACHINE CELL ANALYSIS

Machine Shop Cell Analysis -

A requirement of this Task Order was performance of a feasibility study of flexible cell manufacturing capability in the SA-ALC machine shop (previously MATPNC, et al). As mentioned in my engineering notes of 7/25/90, it was readily apparent that the existing Numerically Controlled (NC) machining operations did not have the workload to justify a cellular structure. This was unfortunate, as these operations are mainly manufacturing, and therefor similar to those commonly seen in a flexible cell machining center. The classical use of flexible cell manufacturing is for high volume and/or geometrically similar workloads. Unfortunately, most depot NC machining operations are of a limited, small batch nature. Even where relatively large production batches are required, these are almost always a "one-time demand", and such workloads would not be maintained over a number of years.

Upon further examination, the remaining machine shop workloads were found to be of a repair-as-required (RAR) nature, and therefor do not readily lend themselves to flexible cell structuring. This is due to the highly variable nature of the kind and degree of repair required.

It appears that the present production practice in this area is the dedication of manpower and machines to a particular component's repair. Basically, one machinist, and one or more machines, are assigned to a specific component. Other components would not normally be repaired using these resources. This naturally removes the need to set up and tear down equipment, and more importantly, it indicates a relative abundance of resources to process the workload.

Many research studies have suggested modelling Flexible Manufacturing Systems (FMS) as closed queuing systems-- that is, queuing systems with a fixed number of units, and no input or output. The justification for this approach is that many real FMSs are maintained at a constant level of work-in-process (WIP). Whenever a unit is removed from the system, another immediately replaces it. The current SA-ALC machining process, given both the variability and unbalanced production flow of the observed operations, would not support this type of structured environment.

Based on these observations, our opinion is that the present manufacturing workloads found in the machine shop do not readily lend themselves to cellular machining practices. Granted, we were unable to coordinate our efforts with engineering support personnel for this area, and in this regard our recommendations may not show consideration of all future ALC production practices. Still, I feel that the logic of our argument is fairly straight forward, and represents valid reasons for not implementing such practices in this area at this time.

In-house Machine Cell Analysis -

Having said the above, I would like to propose a situation which would make such cells feasible. I am speaking of moving machining processes, as well as several other processes, in-house. I have mentioned in several places in my engineering notes the reasons why this should be done. These reasons will also be thoroughly documented in the CSR for this Task Order. Basically, the improvements in component quality and reduced flowtime should far outweigh the expense and effort required in the actual movement of these processes.

While it is difficult to determine the extent of improvements in quality these changes would have, it is somewhat more easy to determine the effect on reduction in flowtime. Using two different simulation tools (the XCELL+ simulator, and the UDOS 2.0 simulation model), I structured hypothetical in-house machining cells. While the structure of these cells is simplistic, and the "flexible" nature of the cell is only somewhat realized, I believe that the possibilities are clearly apparent.

In structuring the cells I used the XCELL+ simulator to produce a simple, two component machine repair center. As I was limited in my structural and analytic capacity by the relatively unsophisticated nature of this program, I also created a three component cell using the UDOS model. Both systems have something to be said for them. While the XCELL+ version does not approach the power and accuracy possible in the UDOS model, it is useful for gaining a graphical understanding of the theoretical process. It is also extremely useful in determining the placement of stock buffers, the "on-screen" formation of queues, and the use of stock "triggers" in a production process.

The real weakness in both of these models has to do with the highly subjective nature of the model inputs, both quantities of components inputted and integral operation times. While these can be argued, I do believe that the assumptions I made were sound, and are based on production practices I have personally witnessed in both private industry and the various ALCs. The historical flowtimes we have observed in GTE backshop operations are excessive by any standards; it is not be unreasonable to expect production practices to conform to those such as I have shown. (The exception would be certain single operation times, which could have more variability due to the nature of depot repair. This is not a significant argument, however, as operation times are only a small portion of the overall flowtimes for present GTE processes).

In any case, I hope that the methodology, if not the actual results, will be of use to our ALC teammates in their efforts to bring GTE backshop workloads in-house. The XCELL+ model and associated software will be delivered to Mr. Gonzales, and a briefing on the format and analysis of this model will be performed at that time. The results of the UDOS run, both the initial and stressed (high inductions) models, are shown on the following pages. The flow charts which follow the model output sheets provide a graphical depiction of the flow of items in the theoretical machine cell. These flow charts should not be considered as floor layout suggestions. The complete models, with associated ops file, are shown in appendix A of this report.

Please note that the flexible nature of such a cell is only touched upon in this model. True flexibility would be gained from grouping workloads, and structuring tear down and set up of equipment in a logical fashion.

The final conclusion is that the structured use of in-house flexible cell machining practices could significantly lower component flowtime, while making more effective use of existing manpower and equipment.

Non-Stressed

```
---------------------------------------------------------------------------------
TOTAL ITEM INDUCTIONS                   :      500       500       500       500      2000

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:    3
-----------------------------------------------------------------------------------------------------
 WCD INDUCTIONS
 --------------

                                          1ST QTR  2ND QTR  3RD QTR  4TH QTR      YTD
                                         -------- -------- -------- -------- ---------
INDUCTIONS OF WCD             TA813F  :      100      100      100      100      400
INDUCTIONS OF WCD             TG631D  :      100      100      100      100      400
INDUCTIONS OF WCD             13095A  :      100      100      100      100      400
INDUCTIONS OF WCD             13094A  :      100      100      100      100      400
INDUCTIONS OF WCD             TG847F  :      100      100      100      100      400

---------------------------------------------------------------------------------
TOTAL WCD INDUCTIONS                  :      500      500      500      500     2000

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:    4
-----------------------------------------------------------------------------------------------------
FLOW CYCLE TIME STATISTICS
--------------------------

                                           AVERAGE                   SIMULATED  SIMULATED
                          HISTORICAL      SIMULATED                   MINIMUM    MAXIMUM    NUMBER    NUMBER
                           FLOWTIME       FLOW TIME   STANDARD      FLOW TIME  FLOW TIME     OF        OF
 ITEM              .        HOURS          HOURS      DEVIATION       HOURS      HOURS     SAMPLES  INDUCTIONS
-----------------        ----------       -------     ---------      -------    -------    -------  ----------

2ND.STG.DIFF.ASSY         3240.00         222.99        59.16          77.27     414.29       398       400
BEARING HSG.              2714.40          56.21        31.73           6.56     148.52       401       400
GTE -180                     0.00          56.21        29.50           6.56     147.53       401       400
GTE -397                     0.00         222.99        40.86         127.27     317.10       398       400
TURBINE BRG. HSG.         2496.00          76.98        65.16           2.51     363.36       401       400
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:    5
-----------------------------------------------------------------------------------------------------
DIRECT LABOR STATISTICS
-----------------------

                                                  SIMULATED                      SIMULATED     SIMULATED
                                                   AVERAGE                        MINIMUM       MAXIMUM     NUMBER
                          EXPECTED  STANDARD        LABOR        STANDARD          LABOR         LABOR        OF
 ITEM                       HOURS     HOURS         HOURS        DEVIATION         HOURS         HOURS      SAMPLES
-----------------        --------  --------       -------       ---------        -------       -------     -------

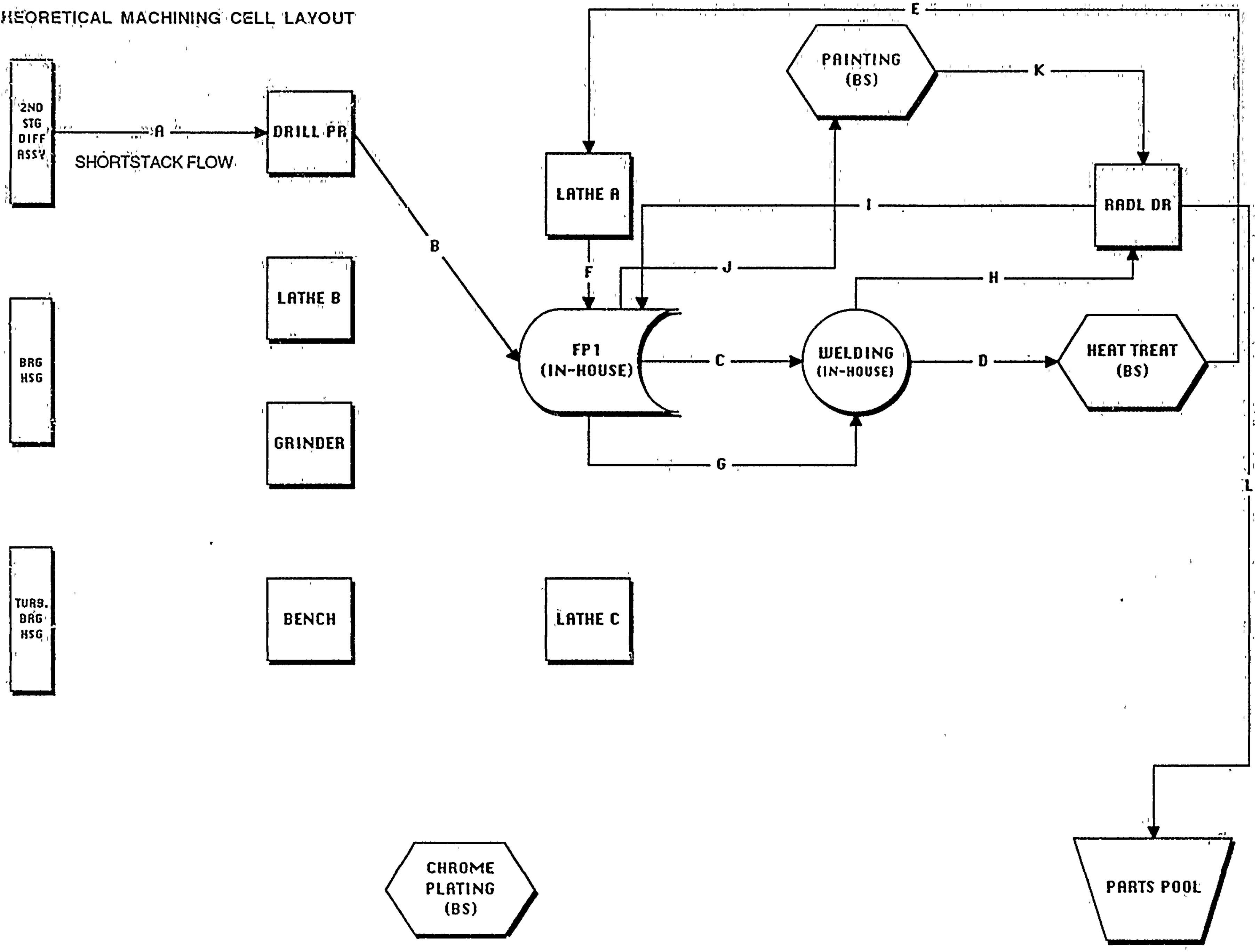
2ND.STG.DIFF.ASSY           5.98     32.40          5.97            0.63            3.91          6.66        398
BEARING HSG.                4.06     27.14          4.10            1.48            0.21          8.44        401
GTE -180                    0.00      0.00          0.00            0.00            0.00          0.00        401
GTE -397                    0.00      0.00          0.00            0.00            0.00          0.00        398
TURBINE BRG. HSG.           1.33     24.96          1.31            0.90            0.00          4.17        401
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:    6
-----------------------------------------------------------------------------------------------------
BACKSHOP DWELL SUMMARY
----------------------

                            AVERAGE                 SIMULATED  SIMULATED
                           SIMULATED                 MINIMUM    MAXIMUM    NUMBER
                           BACKSHOP    STANDARD     BACKSHOP   BACKSHOP      OF
 ITEM                        HOURS    DEVIATION       HOURS      HOURS     SAMPLES
```

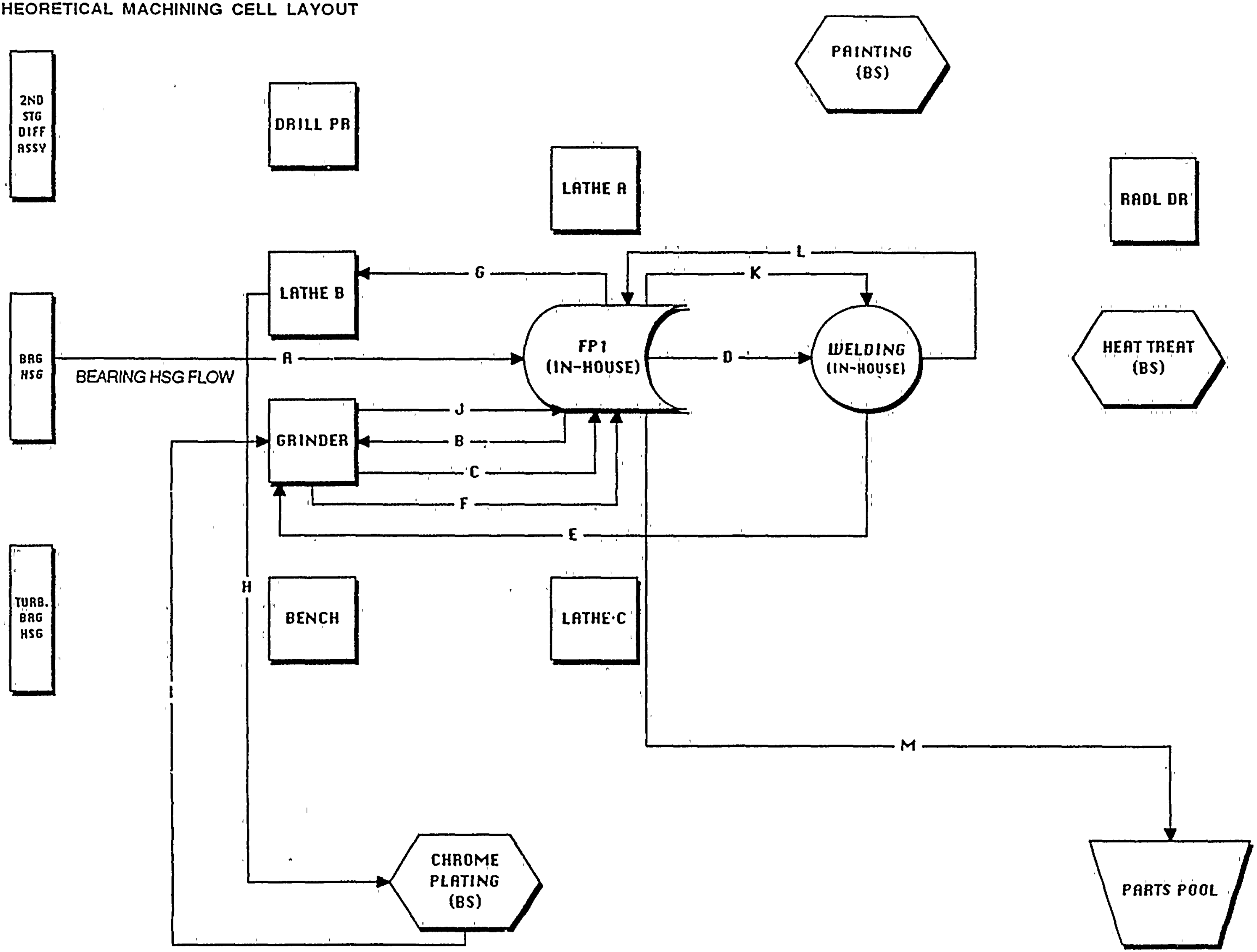
804

579

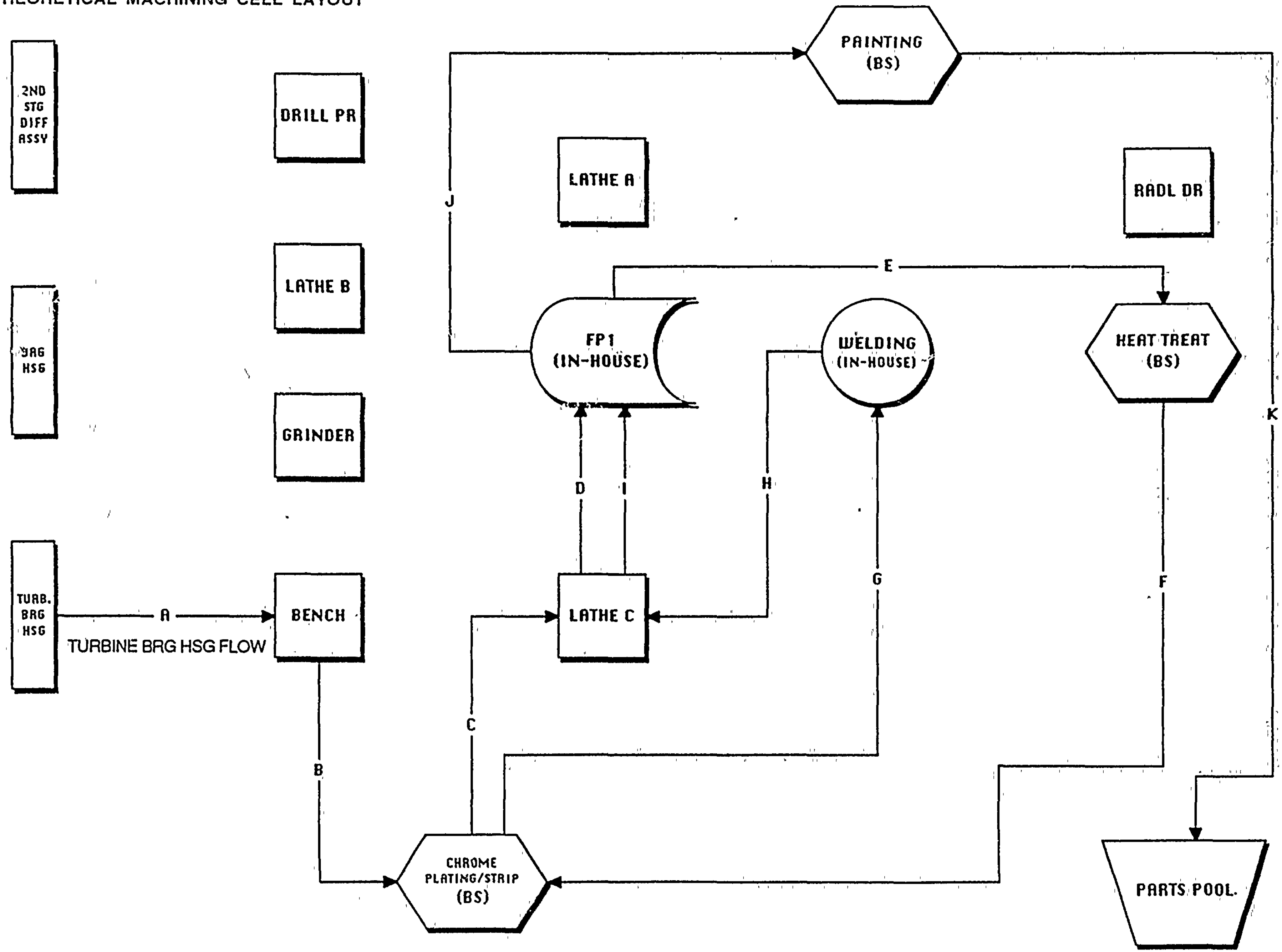
THEORETICAL MACHINING CELL LAYOUT



THEORETICAL MACHINING CELL LAYOUT



THEORETICAL MACHINING CELL LAYOUT



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ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:    1
-----------------------------------------------------------------------------------------------------------
RUN PARAMETERS
--------------
 UDCS     :
This job was run on SAALC - 780 VAX at San Antonio.

 ALC:  SA

 RCC:  MATPGB

 REPORT ID:  CELL

        GTE LINE - MACHINE CELL

 PART FILE:  GTEPART.CEL
 RES  FILE:  GTERES.CEL
 OPER FILE:  GTEOPS.CEL
 ETC  FILE:  GTEETC.CEL

 WEEKENDS - Y

 NUMBER OF QUARTERS -             4

 WARM UP PERIOD; STATS WILL BE CLEARED AT DAY         364

 # OF HOLIDAYS                     0

 HISTORICAL DATA SHIFT FACTOR   8.000000

 BACKSHOP DATA SHIFT FACTOR     24.00000

 NEW DATA FORMATS SELECTED



SIMULATION CPU TIME:        9.88 MINUTES
SIMULATION LAPSE TIME:    714.65 MINUTES

SIMULATION RUN LENGTH: 17472.00 HOURS

Number of Items      :        5
Number of Resources  :       19
Number of WCDs       :        5
Number of Operations :      121
Operations completed :    54851
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:    2
-----------------------------------------------------------------------------------------------------------
 ITEM INDUCTIONS
 ---------------
                                           1ST QTR  2ND QTR  3RD QTR  4TH QTR      YTD
                                           -------  -------  -------  -------  -------
INDUCTIONS OF ITEM 2ND.STG.DIFF.ASSY :        100      100      100      100      400    (MISTR)
INDUCTIONS OF ITEM BEARING HSG.      :        100      100      100      100      400    (MISTR)
INDUCTIONS OF ITEM GTE -180          :        100      100      100      100      400    (MISTR)
INDUCTIONS OF ITEM GTE -397          :        100      100      100      100      400    (MISTR)
INDUCTIONS OF ITEM TURBINE BRG. HSG. :        100      100      100      100      400    (MISTR)
```

NORMAL WORKLOAD

THRU MACHINE CELL

809

```
------------------------------------------------------------------------------
TOTAL ITEM INDUCTIONS               :      500     500     500     500    2000

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   3
------------------------------------------------------------------------------------------------------
 WCD INDUCTIONS
 --------------
                                        1ST QTR  2ND QTR  3RD QTR  4TH QTR      YTD
                                       -------- -------- -------- -------- --------
INDUCTIONS OF WCD          TA813F  :      100      100      100      100      400
INDUCTIONS OF WCD          TG631D  :      100      100      100      100      400
INDUCTIONS OF WCD          13095A  :      100      100      100      100      400
INDUCTIONS OF WCD          13094A  :      100      100      100      100      400
INDUCTIONS OF WCD          TG847F  :      100      100      100      100      400

------------------------------------------------------------------------------
TOTAL WCD INDUCTIONS               :      500      500      500      500     2000

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90   TIME:  11:54:37  REPT.ID: CELL      PAGE:   4
------------------------------------------------------------------------------------------------------
FLOW CYCLE TIME STATISTICS
--------------------------

                                        AVERAGE                 SIMULATED  SIMULATED
                      HISTORICAL      SIMULATED                  MINIMUM    MAXIMUM    NUMBER     NUMBER
                       FLOWTIME       FLOW TIME    STANDARD     FLOW TIME  FLOW TIME     OF         OF
 ITEM                    HOURS          HOURS      DEVIATION      HOURS      HOURS     SAMPLES  INDUCTIONS
------------------   -----------      -------     ----------    -------    -------    -------   ----------

2ND.STG.DIFF.ASSY       3240.00        222.99        59.16        77.27     414.29       398       400
BEARING HSG.            2714.40         56.21        31.73         6.56     148.52       401       400
GTE -180                   0.00         56.21        29.50         6.56     147.53       401       400
GTE -397                   0.00        222.99        40.86       127.27     317.10       398       400
TURBINE BRG. HSG.       2496.00         76.98        65.16         2.51     363.36       401       400

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   5
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DIRECT LABOR STATISTICS
-----------------------

                                                 SIMULATED                   SIMULATED    SIMULATED
                                                  AVERAGE                     MINIMUM      MAXIMUM    NUMBER
                         EXPECTED  STANDARD        LABOR       STANDARD        LABOR        LABOR       OF
 ITEM                      HOURS     HOURS         HOURS       DEVIATION       HOURS        HOURS     SAMPLES
-------------------      --------  ---------      -------     ----------      -------      -------    -------

2ND.STG.DIFF.ASSY           5.98      32.40         5.97          0.63          3.91         6.66       398
BEARING HSG.                4.06      27.14         4.10          1.48          0.21         8.44       401
GTE -180                    0.00       0.00         0.00          0.00          0.00         0.00       401
GTE -397                    0.00       0.00         0.00          0.00          0.00         0.00       398
TURBINE BRG. HSG.           1.33      24.96         1.31          0.90          0.00         4.17       401

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   6
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BACKSHOP DWELL SUMMARY
----------------------

                          AVERAGE                  SIMULATED  SIMULATED
                         SIMULATED                  MINIMUM    MAXIMUM    NUMBER
                          BACKSHOP    STANDARD     BACKSHOP   BACKSHOP    OF
 ITEM                        HOURS    DEVIATION       HOURS      HOURS    SAMPLES
```

```
-----------------   --------  ---------   --------   -------   -------

2ND.STG.DIFF.ASSY      94.17      41.98      14.48    290.10      398
BEARING HSG.            8.42       5.51       1.66     72.17      401
GTE -180                0.00       0.00       0.00      0.00      401
GTE -397                0.00       0.00       0.00      0.00      398
TURBINE BRG. HSG.      52.03      56.02       0.00    335.67      401

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL       PAGE:    7
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PROCESS TIMES SUMMARY
---------------------

                       HISTOR.   SIMULATED    WAITING FOR                                                NUMBER
                       FLOW        FLOW       RESOURCES              PROCESSING FLOW      BACKSHOP         OF
 ITEM                  HOURS       HOURS      HOURS      %           HOURS      %       HOURS     %      SAMPLES
-----------------      -------   ---------    ------   ------        -----    ----      -----   -----    -------

2ND.STG.DIFF.ASSY      3240.0      223.0      108.0    48.4%         20.9     9.4%       94.2   42.2%      398
BEARING HSG.           2714.4       56.2       29.6    52.7%         18.2    32.3%        8.4   15.0%      401
GTE -180                  0.0       56.2       56.2   100.0%          0.0     0.0%        0.0    0.0%      401
GTE -397                  0.0      223.0      223.0   100.0%          0.0     0.0%        0.0    0.0%      398
TURBINE BRG. HSG.      2496.0       77.0       22.8    29.6%          2.1     2.8%       52.0   67.6%      401

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL       PAGE:  . 8
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 RESOURCE QUEUE STATISTICS
-------------------------

                 AVERAGE               MAXIMUM    AVERAGE     CURRENT     THE
RESOURCE         QUEUE     STANDARD    QUEUE      QUEUE       QUEUE       BLAKE
QUEUE            QUANTITY  DEVIATION   QUANTITY   WAIT(hrs)   QUANTITY    STATISTIC
--------         --------  ---------   --------   ---------   --------    ---------

BOOTH     EQ       0.04      0.25        8.00       0.39          1         0.02
CHRM TNK  EQ       0.01      0.09        2.00       1.06          0         0.01
DB09      MP       0.80      1.01        8.00       8.35          0         6.69
DRILL PR  EQ       0.00      0.09        5.00       0.22          0         0.00
FPI       EQ       0.04      0.23        7.00       0.26          0         0.01
GRINDER   EQ       0.16      0.52        5.00       1.92          0         0.30
JA09      MP       3.34      2.67       18.00       5.97          8        19.94
LATHEA    EQ       0.01      0.10        5.00       0.28          0         0.00
LATHEB    EQ       0.05      0.25        4.00       4.09          0         0.20
LATHEC    EQ       0.00      0.02        1.00       0.52          0         0.00
OVEN      EQ       0.03      0.17        2.00       0.60          0         0.02
PT05      MP       1.42      1.80        9.00      12.12          1        17.21
RADL DR   EQ       0.87      1.69        9.00       4.08          0         3.56
STRP TNK  EQ       0.00      0.02        1.00       0.06          0         0.00
UA09      MP       0.05      0.24        4.00       6.30          0         0.33
WELDER    EQ       0.26      0.84        8.00       2.60          0         0.68
WJ09      MP       0.80      1.10        9.00      11.92          2         9.58
WK09      MP       0.34      0.69        6.00       4.49          0         1.55
WI09      MP       0.47      0.71        4.00       6.29          2         2.93

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL       PAGE:    9
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ASSEMBLY STATISTICS
-------------------

                 TOTAL  DELAYED      WAIT
                                   (HOURS)   --------WAITING QUEUE COUNT -----
```

810/811

812

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PARENT ITEM      INDUCT  OPERATIONS  AVERAGE  AVERAGE STD.DEV. MAXIMUM CURRENT
-----------      ------  ----------  -------  ------- -------- ------- -------
GTE -180            400         400     56.2      2.6      1.7     9.0       1
GTE -397            400         400    222.2     10.2      3.5    22.0      12

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   10
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WORK IN PROCESS
---------------

                                                                      AVERAGE  AVERAGE  CURRENT
                  ALLOWABLE                                           WAITING  QUANTITY QUANTITY
ITEM              QUANTITY  AVERAGE  STD.DEV. MINIMUM  MAXIMUM  CURRENT TIME     WAITING  WAITING
------------      --------  -------  -------- -------- -------- ------- -------- -------- --------
2ND.STG.DIFF.ASSY 99999        10.2       3.5        2       22      12     ** NONE WAITED **
BEARING HSG.      99999         2.6       1.7        0        9       1     ** NONE WAITED **
GTE -180          99999         2.6       1.7        0        9       1     ** NONE WAITED **
GTE -397          99999        10.2       3.5        2       22      12     ** NONE WAITED **
TURBINE BRG. HSG. 99999         3.5       1.9        0       14       2     ** NONE WAITED **

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   11
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DEDICATED STOCK STATISTICS - Parallel Operations
------------------------------------------------

                                          WAIT
                   TOTAL   DELAYED      (HOURS)  -------WAITING QUEUE COUNT------
STOCK ITEM         INDUCT  OPERATIONS   AVERAGE  AVERAGE STD.DEV. MAXIMUM CURRENT
----------         ------  ----------   -------  ------- -------- ------- -------

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   12
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FLOATING STOCK STATISTICS
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                   FLOATING
                    STOCK    -QUANTITY IN STOCK & AVAILABLE FOR ASSEMBLY-
STOCK ITEM         QUANTITY  AVERAGE  STD.DEV. MINIMUM  MAXIMUM  CURRENT
-----------        --------  -------  -------- -------- -------- -------
2ND.STG.DIFF.ASSY         0     0.00      0.00     0.00     0.00       0
BEARING HSG.              0     0.00      0.00     0.00     0.00       0
TURBINE BRG. HSG.         0     6.67      2.86     0.00    17.00      10

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   13
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 RESOURCE UTILIZATION by SHIFT
 ----------------------------

                                           ----AVERAGE NUMBER IN EACH STATE-----        ------BATCHING------
                               NUMBER SHIFT                  PREV.            OTHER     MIN    MAX    AVG     AVG
CODE      DESCRIPTION   SHIFT AVAIL.  UTIL.   IDLE   IN USE  MAINT.  FAILURE  DOWN      SIZE   SIZE   SIZE    PARTS  COUNT
-------------------     ----- ------  -----   ----   ------  ------  -------  -----     ------ ------ ------  ------ -----
BOOTH     PNT             1    1.0    0.07    0.92    0.07    0.01    0.00    0.00      1.00   8.00   1.40    1.40    506
BATCH SZ     1 /   20     2    0.0   NO VALUES RECORDED
                          3    0.0   NO VALUES RECORDED
                          4    0.0   NO VALUES RECORDED
                          5    0.0   NO VALUES RECORDED
                          6    0.0   NO VALUES RECORDED

CHRM TNK TNK              1    1.0    0.03    0.96    0.03    0.01    0.00    0.00      1.00   2.00   1.02    1.02     51
BATCH SZ     1 /   10     2    0.0   NO VALUES RECORDED
                          3    0.0   NO VALUES RECORDED
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588

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                         4    0.0  NO VALUES RECORDED
                         5    0.0  NO VALUES RECORDED
                         6    0.0  NO VALUES RECORDED

DB09     MACH            1    2.0    0.16   0.39    0.11    0.00     0.00     0.29
                         2    0.0  NO VALUES RECORDED
                         3    0.0  NO VALUES RECORDED
                         4    0.0  NO VALUES RECORDED
                         5    0.0  NO VALUES RECORDED
                         6    0.0  NO VALUES RECORDED

DRILL PR DRILL           1    1.0    0.06   0.93    0.06    0.00     0.00     0.00
                         2    0.0  NO VALUES RECORDED
                         3    0.0  NO VALUES RECORDED
                         4    0.0  NO VALUES RECORDED
                         5    0.0  NO VALUES RECORDED
                         6    0.0  NO VALUES RECORDED

FPI      FPI             1    1.0    0.23   0.77    0.22    0.00     0.00     0.00
                         2    0.0  NO VALUES RECORDED
                         3    0.0  NO VALUES RECORDED
                         4    0.0  NO VALUES RECORDED
                         5    0.0  NO VALUES RECORDED
                         6    0.0  NO VALUES RECORDED

GRINDER  GRND            1    1.0    0.36   0.64    0.36    0.00     0.00     0.00
                         2    0.0  NO VALUES RECORDED
                         3    0.0  NO VALUES RECORDED
                         4    0.0  NO VALUES RECORDED
                         5    0.0  NO VALUES RECORDED
                         6    0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources.
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   14
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 RESOURCE UTILIZATION by SHIFT
 ----------------------------
                                             ----AVERAGE NUMBER IN EACH STATE-----       ------BATCHING------
                           NUMBER  SHIFT                  PREV.             OTHER        MIN      MAX      AVG      AVG
CODE     DESCRIPTION SHIFT AVAIL.  UTIL.    IDLE  IN USE  MAINT. FAILURE    DOWN         SIZE     SIZE     SIZE     PARTS  COUNT
------------------- ----- ------  -----    ----  ------  ------ -------   -----        ------   ------   ------   ------ -----
JA09     MACH            1    5.0    0.34   0.46    0.24    0.00     0.00     0.29
                         2    0.0  NO VALUES RECORDED
                         3    0.0  NO VALUES RECORDED
                         4    0.0  NO VALUES RECORDED
                         5    0.0  NO VALUES RECORDED
                         6    0.0  NO VALUES RECORDED

LATHEA   LATHE           1    1.0    0.05   0.95    0.05    0.00     0.00     0.00
                         2    0.0  NO VALUES RECORDED
                         3    0.0  NO VALUES RECORDED
                         4    0.0  NO VALUES RECORDED
                         5    0.0  NO VALUES RECORDED
                         6    0.0  NO VALUES RECORDED

LATHEB   LATHE           1    1.0    0.18   0.82    0.18    0.00     0.00     0.00
                         2    0.0  NO VALUES RECORDED
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813

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                       3     0.0  NO VALUES RECORDED
                       4     0.0  NO VALUES RECORDED
                       5     0.0  NO VALUES RECORDED
                       6     0.0  NO VALUES RECORDED

LATHEC    LATHE        1     1.0    0.05   0.95    0.05     0.00      0.00      0.00
                       2     0.0  NO VALUES RECORDED
                       3     0.0  NO VALUES RECORDED
                       4     0.0  NO VALUES RECORDED
                       5     0.0  NO VALUES RECORDED
                       6     0.0  NO VALUES RECORDED

OVEN      OVEN         1     6.0    0.01   0.98    0.01     0.00      0.00      0.00          1.00      1.00      1.00      1.00      359
BATCH SZ     1 /     6 2     0.0  NO VALUES RECORDED
                       3     0.0  NO VALUES RECORDED
                       4     0.0  NO VALUES RECORDED
                       5     0.0  NO VALUES RECORDED
                       6     0.0  NO VALUES RECORDED

PT05      PAINT        1     3.0    0.03   0.65    0.02     0.00      0.00      0.33
                       2     0.0  NO VALUES RECORDED
                       3     0.0  NO VALUES RECORDED
                       4     0.0  NO VALUES RECORDED
                       5     0.0  NO VALUES RECORDED
                       6     0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources.

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:  15
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 RESOURCE UTILIZATION by SHIFT
 ----------------------------
                                            ----AVERAGE NUMBER IN EACH STATE-----         ------BATCHING------
                             NUMBER  SHIFT                   PREV.              OTHER    MIN     MAX     AVG     AVG
CODE     DESCRIPTION   SHIFT AVAIL.  UTIL.    IDLE   IN USE  MAINT.  FAILURE    DOWN     SIZE    SIZE    SIZE    PARTS   COUNT
-------------------    ----- ------  -----    ----   ------  ------  -------    -----   ------  ------  ------  ------  -----
RADL DR  DRILL         1     1.0    0.46   0.54    0.46     0.00      0.00      0.00
                       2     0.0  NO VALUES RECORDED
                       3     0.0  NO VALUES RECORDED
                       4     0.0  NO VALUES RECORDED
                       5     0.0  NO VALUES RECORDED
                       6     0.0  NO VALUES RECORDED

STRP TNK TNK           1     1.0    0.02   0.98    0.02     0.00      0.00      0.00          1.00      1.00      1.00      1.00       44
BATCH SZ     1 /    10 2     0.0  NO VALUES RECORDED
                       3     0.0  NO VALUES RECORDED
                       4     0.0  NO VALUES RECORDED
                       5     0.0  NO VALUES RECORDED
                       6     0.0  NO VALUES RECORDED

UA09     PLATE         1     5.0    0.01   0.70    0.01     0.00      0.00      0.29
                       2     0.0  NO VALUES RECORDED
                       3     0.0  NO VALUES RECORDED
                       4     0.0  NO VALUES RECORDED
                       5     0.0  NO VALUES RECORDED
                       6     0.0  NO VALUES RECORDED

WELDER   WELD          1     1.0    0.38   0.62    0.37     0.00      0.00      0.00
```

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                          2     0.0  NO VALUES RECORDED
                          3     0.0  NO VALUES RECORDED
                          4     0.0  NO VALUES RECORDED
                          5     0.0  NO VALUES RECORDED
                          6     0.0  NO VALUES RECORDED

WJ09     HT               1     6.0    0.03   0.69    0.02    0.00    0.00    0.29
                          2     0.0  NO VALUES RECORDED
                          3     0.0  NO VALUES RECORDED
                          4     0.0  NO VALUES RECORDED
                          5     0.0  NO VALUES RECORDED
                          6     0.0  NO VALUES RECORDED

WK09     WELD             1     1.0    0.33   0.47    0.23    0.00    0.00    0.30
                          2     0.0  NO VALUES RECORDED
                          3     0.0  NO VALUES RECORDED
                          4     0.0  NO VALUES RECORDED
                          5     0.0  NO VALUES RECORDED
                          6     0.0  NO VALUES RECORDED

Note: Remember that the utilizations reflect
      only 80% of the workload and the other
      20% may not be spread evenly across all
      resources.

ALC: SA   RCC: MATPGB   QUARTER: 4  DATE: 28-NOV-90  TIME: 11:54:37  REPT.ID: CELL      PAGE: 16
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RESOURCE UTILIZATION by SHIFT
-----------------------------
                                                ----AVERAGE NUMBER IN EACH STATE-----          ------BATCHING------
                              NUMBER  SHIFT                    PREV.            OTHER     MIN     MAX     AVG     AVG
CODE     DESCRIPTION    SHIFT AVAIL.  UTIL.     IDLE   IN USE  MAINT.  FAILURE   DOWN     SIZE    SIZE    SIZE    PARTS  COUNT
-------- -------------  ----- ------  -----     ----   ------  ------  -------  -----    ------  ------  ------  ------  -----
WI09     WELD             1     1.0    0.36     0.45    0.25    0.00    0.00    0.30
                          2     0.0  NO VALUES RECORDED
                          3     0.0  NO VALUES RECORDED
                          4     0.0  NO VALUES RECORDED
                          5     0.0  NO VALUES RECORDED
                          6     0.0  NO VALUES RECORDED

Note: Remember that the utilizations reflect
      only 80% of the workload and the other
      20% may not be spread evenly across all
      resources

ALC: SA   RCC: MATPGB   QUARTER: 4  DATE: 28-NOV-90  TIME: 11:54:37  REPT.ID: CELL      PAGE: 17
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 ITEM NAME: 2ND.STG.DIFF.ASSY  WCD NAME: TA813F

WCD by OPERATION STATISTIC AVERAGES
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                                                         AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED     QUEUED     QUEUED    SCHEDULED   SIMULATED                     OCC
 CODE     QTY       QTY          QTY        HRS         HRS         HRS        DESC    RCC     FAC
 ----  --------  --------   ----------  --------  ----------  ----------      ----  ------   ----
 0100    400.      400.          0.        0.00        1.95        1.95       IN    MATPNC   1.00
 0140    400.      400.        315.        2.22        0.32        0.32       PROC  MATPNC   1.00  JA09,DRILLPR
 0199    400.      400.          0.        0.00        0.00        0.00       CUT   MATPNC   1.00
 0200    400.      360.          0.        0.00        1.02        1.02       IN    MATPNB   0.90
```

815

590

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 0240     400.      360.        149.        1.04       0.21         0.36       PROC   MATPNB   0.90  DB09,FPI
 0299     400.      349.          0.        0.00       0.00         0.00       OUT    MATPNB   0.90
 0300     400.      353.          0.        0.00       0.96         0.96       IN     MATPNN   0.90
 0340     400.      360.        230.       11.62       0.90         4.29       PROC   MATPNN   0.90  XK09,WELDER
 0399     400.      361.          0.        0.00       0.00         0.00       OUT    MATPNN   0.90
 0400     400.      369.          0.        0.00      25.45        25.45       IN     MAEPDB   0.90
 0440     400.      361.        268.       24.23       0.50         1.25       PROC   MAEPDB   0.90  WC09,OVEN(be)
 0499     398.      365.          0.        0.00       9.41         9.41       OUT    MAEPDB   0.90
 0500     398.      366.          0.        0.00       1.07         1.07       IN     MATPNC   0.90
 0540     398.      360.        318.       21.44       0.30         0.45       PROC   MATPNC   0.90  JA09,LATHEA
 0599     397.      348.          0.        0.00       0.00         0.00       OUT    MATPNC   0.90
 0600     397.      352.          0.        0.00       1.00         1.00       IN     MATPNB   0.90
 0640     397.      349.        154.        5.22       0.21         0.37       PROC   MATPNB   0.90  DB09,FPI
 0699     397.      348.          0.        0.00       0.00         0.00       OUT    MATPNB   0.90
 0700     397.      323.          0.        0.00       0.95         0.95       IN     MATPNN   0.80
 0740     397.      309.        162.        2.99       1.27         4.21       PROC   MATPNN   0.80  WI09,WELDER
 0799     395.      309.          0.        0.00       0.00         0.00       OUT    MATPNN   0.80
 0800     395.      395.          0.        0.00       0.95         0.95       IN     MATPNC   1.00
 0840     395.      395.        256.       31.45       0.30         1.79       PROC   MATPNC   1.00  JA09,RADLDR
 0899     398.      398.          0.        0.00       0.00         0.00       OUT    MATPNC   1.00
 0900     398.      198.          0.        0.00       0.94         0.94       IN     MATPNB   0.50
 0940     398.      202.         73.        8.59       0.21         1.26       PROC   MATPNB   0.50  DB09,FPI
 0999     398.      208.          0.        0.00       0.00         0.00       OUT    MATPNB   0.50
 1000     398.      360.          0.        0.00      22.62        22.62       IN     MATPMM   0.90
 1040     398.      362.        288.       24.81       0.26         0.80       PROC   MATPMM   0.90  PT05,BOOTH(be)
 1099     398.      372.          0.        0.00      34.03        34.03       OUT    MATPMM   0.90
 1100     398.      398.          0.        0.00       1.97         1.97       IN     MATPNC   1.00
 1140     398.      398.        367.  [illegible]      2.11         7.98       PROC   MATPNC   1.00  JA09,RADLDR
 1199     398.      398.          0.        0.00       0.00         0.00       OUT    MATPNC   1.00
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   18
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 ITEM NAME: BEARING HSG.       WCD NAME: TG631D

WCD by OPERATION STATISTIC AVERAGES
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                                                    AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED     QUEUED    SCHEDULED   SIMULATED                 OCC
 CODE     QTY       QTY        QTY        HRS        HRS         HRS        DESC   RCC    FAC
 ----  --------  --------  ----------  --------  ----------  ----------    ----  ------  ----
 0100     400.      229.          0.       0.00       2.08        2.08       IN    MATPNC  0.59
 0140     400.      237.        204.       2.50       0.38        0.38       PROC  MATPNC  0.59  JA09
 0199     400.      243.          0.       0.00       0.00        0.00       OUT   MATPNC  0.59
 0200     400.        8.          0.       0.00       0.77        0.77       IN    MATPNB  0.05
 0240     400.       20.         16.       2.51       0.21        0.21       PROC  MATPNB  0.05  DB09,FPI
 0299     400.       21.          0.       0.00       0.00        0.00       OUT   MATPNB  0.05
 0300     400.       93.          0.       0.00       1.04        1.04       IN    MATPNC  0.23
 0340     400.       92.         63.       4.74       1.05        2.25       PROC  MATPNC  0.23  JA09,GRINDER
 0399     400.      100.          0.       0.00       0.00        0.00       OUT   MATPNC  0.23
 0400     400.      310.          0.       0.00       0.93        0.93       IN    MATPNB  0.77
 0440     400.      309.        152.       2.97       0.21        0.39       PROC  MATPNB  0.77  DB09,FPI
 0499     400.      294.          0.       0.00       0.00        0.00       OUT   MATPNB  0.77
 0500     400.      281.          0.       0.00       1.08        1.08       IN    MATPNN  0.73
 0540     400.      289.         46.      10.58       0.25        0.67       PROC  MATPNN  0.73  WI09
 0599     400.      310.          0.       0.00       0.00        0.00       OUT   MATPNN  0.73
 0600     400.      287.          0.       0.00       0.94        0.94       IN    MATPNC  0.73
 0640     400.      287.        143.       9.65       1.05        5.22       PROC  MATPNC  0.73  JA09,GR[illegible]DER
 0699     400.      279.          0.       0.00       0.00        0.00       OUT   MATPNC  0.73
 0700     400.      298.          0.       0.00       1.12        1.12       IN    MATPNB  0.73
 0740     400.      290.         97.      14.55       0.21        1.29       PROC  MATPNB  0.73  DB09,FPI
 0799    402.     300.        0.      0.00     0.00      0.00    OUT    MATPNB  0.73
 0800    402.     282.        0.      0.00     0.92      0.92    IN     MATPNC  0.68
 0840    402.     258.       92.     18.15     0.84      4.54    PROC   MATPNC  0.68  JA09,LATHEB
 0899    402.     279.        0.      0.00     0.00      0.00    OUT    MATPNC  0.68
 0900    402.       6.        0.      0.00    22.79     22.79    IN     MAEIAA  0.01
 0940    402.       2.        0.      0.00     1.50      1.50    PROC   MAEIAA  0.01
 0999    402.       2.        0.      0.00    24.0.     24.01    OUT    MAEIAA  0.01
 1000    402.     268.        0.      0.00     0.93      0.98    IN     MATPNC  0.68
 1040    402.     268.      173.      9.94     1.05      5.03    PROC   MATPNC  0.68  JA09,GRINDER
 1099    401.     278.        0.      0.00     0.00      0.00    OUT    MATPNC  0.68
 1100    401.      42.        0.      0.00     0.92      0.92    IN     MATPNN  0.09
 1140    401.      38.       25.      9.24     1.69     10.04    PROC   MATPNN  0.09  WI09,WELDER
 1199    401.      32.        0.      0.00     0.00      0.00    OUT    MATPNN  0.09
 1200    401.      54.        0.      0.00     0.87      0.87    IN     MATPNC  0.14
 1240    401.      70.       25.      8.70     1.05      3.94    PROC   MATPNC  0.14  JA09,GRINDER
 1299    401.      48.        0.      0.00     0.00      0.00    OUT    MATPNC  0.14
 1300    401.     249.        0.      0.00     1.01      1.01    IN     MATPNB  0.64
 1340    401.     253.       98.     12.12     0.21      1.13    PROC   MATPNB  0.64  DB09,FPI
 1399    401.     250.        0.      0.00     0.00      0.00    OUT    MATPNB  0.64
 1400    401.     256.        0.      0.00     1.15      1.15    IN     MATPNN  0.59
 1440    401.     244.       75.     20.99     0.25      0.78    PROC   MATPNN  0.59  WI09
 1499    401.     240.        0.      0.00     0.00      0.00    OUT    MATPNN  0.59
 1500    401.      58.        0.      0.00     1.02      1.02    IN     MATPNC  0.14
 1540    401.      65.       12.     11.51     2.38     13.56    PROC   MATPNC  0.14  JA09,LATHEB
 1599    401.      58.        0.      0.00     0.00      0.00    OUT    MATPNC  0.14
 1600    401.     194.        0.      0.00     1.05      1.05    IN     MATPNB  0.50
 1640    401.     211.       67.      8.53     0.21      1.22    PROC   MATPNB  0.50  DB09,FPI
 1699    401.     210.        0.      0.00     0.00      0.00    OUT    MATPNB  0.50
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   19
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 ITEM NAME: GTE -180          WCD NAME: 13095A

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                   AVERAGE     AVERAGE
  OPER  POTENTIAL PROCESSED   QUEUED     QUEUED   SCHEDULED   SIMULATED                     OCC
  CODE     QTY       QTY        QTY        HRS       HRS         HRS        DESC   RCC      FAC
  ----  --------- --------  ---------- --------- ----------  ----------   ----   ------   ----
  0000    400.     400.         0.       0.00      0.00        0.00     IN     MATPGB   1.00
  0010    400.     400.         0.       0.00      0.00        0.00     DIS    MATPGB   1.00
  0020    400.     400.         0.       0.00      0.00        0.00     KIT    MATPGB   1.00
  0030    400.     400.       401.      56.21      0.00        0.00     ASSY   MATPGB   1.00  ,as
  0099    401.     401.         0.       0.00      0.00        0.00     OUT    MATPGB   1.00
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL      PAGE:   20
------------------------------------------------------------------------------------------------------

 ITEM NAME: GTE -397          WCD NAME: 13094A

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                   AVERAGE     AVERAGE
  OPER  POTENTIAL PROCESSED   QUEUED     QUEUED   SCHEDULED   SIMULATED                     OCC
  CODE     QTY       QTY        QTY        HRS       HRS         HRS        DESC   RCC      FAC
  ----  --------- --------  ---------- --------- ----------  ----------   ----   ------   ----
  0000    400.     400.         0.       0.00      0.00        0.00     IN     MATPGB   1.00
  0010    400.     400.         0.       0.00      0.00        0.00     DIS    MATPCB   1.00
```

593

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 0020      400.      400.          0.       0.00        0.00          0.00      KIT    MATPGB   1.00
 0030      400.      400.        398.     222.99        0.00          0.00      ASSY   MATPGB   1.00  ,as
 0099      398.      398.          0.       0.00        0.00          0.00      OUT    MATPGB   1.00

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL       PAGE:   21
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  ITEM NAME: TURBINE BRG. HSG.  WCD NAME: TG847F

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                             AVERAGE       AVERAGE
 OPER  POTENTIAL PROCESSED       QUEUED     QUEUED     SCHEDULED    SIMULATED                    OCC
 CODE     QTY       QTY            QTY        HRS          HRS          HRS       DESC   RCC      FAC
 ----  --------  --------     ----------  --------   ----------   ----------     ----  ------   ----
 0100     400.      129.           0.       0.00         1.87         1.87       IN     MATPNC   0.35
 0140     400.      136.         124.       2.20         0.18         0.18       PROC   MATPNC   0.35  JA09
 0199     400.      137.           0.       0.00         0.00         0.00       OUT    MATPNC   0.35
 0200     400.       27.           0.       0.00        32.45        32.45       IN     MAEIAA   0.09
 0240     400.       44.          26.       4.26         0.95         0.95       PROC   MAEIAA   0.09  UA09,STRPTNK(be)
 0299     400.       29.           0.       0.00        38.01        38.01       OUT    MAEIAA   0.09
 0300     400.       21.           0.       0.00         1.10         1.10       IN     MATPNC   0.06
 0340     400.       19.          12.       3.60         1.00         1.00       PROC   MATPNC   0.06  JA09,LATHEC
 0399     400.       30.           0.       0.00         0.00         0.00       OUT    MATPNC   0.06
 0400     403        75.           0.       0.00         0.83         0.83       IN     MATPNB   0.21
 0440     400.       89.          77.       3.72         0.21         0.21       PROC   MATPNB   0.21  DB09,FPI
 0499     400.       86.           0.       0.00         0.00         0.00       OUT    MATPNB   0.21
 0500     100.       61.           0.       0.00        17.45        17.45       IN     MAEPDB   0.15
 0540     400.       58.          30.      10.19         0.75         1.89       PROC   MAEPDB   0.15  WJ09
 0599     400.       65.           0.       0.00        33.42        33.42       OUT    MAEPDB   0.15
 0600     400.       61.           0.       0.00        82.61        84.02       IN     MAEIAA   0.15
 0640     400.       50.          22.      12.16         1.15         2.47       PROC   MAEIAA   0.15  UA09,CHRMTNK(be)
 0699     400.       65.           0.       0.00        26.74        26.74       OUT    MAEIAA   0.15
 0700     400.       76.           0.       0.00         1.07         1.07       IN     MATPNN   0.18
 0740     400.       79.          48.      20.64         1.27         2.58       PROC   MATPNN   0.18  WK09
 0799     400.       62.           0.       0.00         0.00         0.00       OUT    MATPNN   0.18
 0800     400.       75.           0.       0.00         1.01         1.01       IN     MATPNC   0.21
 0840     400.       82.          38.      16.86         1.00         1.67       PROC   MATPNC   0.21  JA09,LATHEC
 0899     400.       80.           0.       0.00         0.00         0.00       OUT    MATPNC   0.21
 0900     400.      141.           0.       0.00         1.00         1.00       IN     MATPNB   0.35
 0940     400.      140.          89.       8.45         0.21         0.34       PROC   MATPNB   0.35  DB09,FPI
 0999     400.      116.           0.       0.00         0.00         0.00       OUT    MATPNB   0.35
 1000     400.      331.           0.       0.00        24.12        24.12       IN     MATPMM   0.85
 1040     400.      346.         260.      20.70         0.33         0.38       PROC   MATPMM   0.85  PT05,BOOTH(be)
 1099     401.      340.           0.       0.00         0.00         0.00       OUT    MATPMM   0.85

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  28-NOV-90  TIME:  11:54:37  REPT.ID: CELL       PAGE:   22
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BACKSHOP DWELL TIMES BY BACKSHOP RCC
------------------------------------

                                           AVERAGE
ITEM                           RCC          HOURS
-------------------         --------      -------
2ND.STG.DIFF.ASSY           MATPNC          5.85
2ND.STG.DIFF.ASSY           MATPNB          2.27
2ND.STG.DIFF.ASSY           MATPNN          1.63
2ND.STG.DIFF.ASSY           MAEPDB         32.11
```

818

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2ND.STG.DIFF.ASSY          MATPMM      52.27

BEARING HSG.               MATPNC       3.67
BEARING HSG.               MATPNB       2.68
BEARING HSG.               MATPNN       1.59
BEARING HSG.               MAEIAA       0.46

GTE -180              *** NO BACKSHOP ACTIVITY *****

GTE -397              *** NO BACKSHOP ACTIVITY *****

TURBINE BRG. HSG.          MATPNC       0.85
TURBINE BRG. HSG.          MAEIAA      22.10
TURBINE BRG. HSG.          MATPNB       0.51
TURBINE BRG. HSG.          MAEPDB       8.09
TURBINE BRG. HSG.          MATPNN       0.20
TURBINE BRG. HSG.          MATPMM      19.96

ALC:  SA   RCC:  MMTPGB   QUARTER:  4  DATE:   28-NOV-90  TIME:   11:54:37  REPT.ID: CELL       PAGE:   23
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HISTORICAL vs. SIMULATED COMPARISON
-----------------------------------

                       HISTORICAL VALUES                    SIMULATED VALUES
                      FLOWTIME   STANDARD   SAMPLE   FLOWTIME   STANDARD   SAMPLE    WORKLOAD   PERCENTAGE
     ITEM              HOURS     DEVIATION   SIZE     HOURS     DEVIATION   SIZE     WEIGHT     DIFFERENCE
------------------   ----------------------------   ----------------------------   --------   ----------
2ND.STG.DIFF.ASSY     3240.00        0.00     0        222.99       59.16    398      0.000        93.12
BEARING HSG.          2714.40        0.00     0         56.21       31.73    401      0.000        97.93
GTE -180                 0.00        0.00     0         56.21       29.50    401      0.000         0.00
GTE -397                 0.00        0.00     0        222.99       40.86    398      0.000         0.00
TURBINE BRG. HSG.     2496.00        0.00     0         76.98       65.16    401      0.000        96.92

ITEM 2ND.STG.DIFF.ASSY  EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

ITEM BEARING HSG.       EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

ITEM GTE -180           EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

ITEM GTE -397           EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

ITEM TURBINE BRG. HSG.  EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

NOT ENOUGH ITEMS REMAINING TO CONDUCT VALIDATION TEST
```

819

594

```
 THIS USAGE REPORT IS FOR RCC: NATFGB
 THIS REPORT PROVIDES THE ESTIMATED USAGE FOR
 EACH RESOURCE BY PART.

RESOURCE NAME:BOOTH

    PART               YEARLY         TOTAL
    NAME             INDUCTIONS    HOURS NEEDED
-------------------------------------------------

TURBINE BRG. HSG.      400.          112.20

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:     112.2000

                     TOTAL HOURS AVAILABLE:    2080.000

RESOURCE NAME:CHRM TNK

    PART               YEARLY         TOTAL
    NAME             INDUCTIONS    HOURS NEEDED
-------------------------------------------------

BEARING HSG.           400.            6.00
TURBINE BRG. HSG.      400.           69.00

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:     75.00000

                     TOTAL HOURS AVAILABLE:    2080.000

RESOURCE NAME:DB09

    PART               YEARLY         TOTAL
    NAME             INDUCTIONS    HOURS NEEDED
-------------------------------------------------

2ND.STG.DIFF.ASSY      400.          193.20
BEARING HSG.           400.          225.96
TURBINE BRG. HSG.      400.           47.04

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:     466.2000

                     TOTAL HOURS AVAILABLE:    2939.300

RESOURCE NAME:DRILL PR

    PART               YEARLY         TOTAL
    NAME             INDUCTIONS    HOURS NEEDED
-------------------------------------------------

2ND.STG.DIFF.ASSY      400.          128.00

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:     128.0000

                     TOTAL HOURS AVAILABLE:    2080.000

RESOURCE NAME:FPI
```

```
    PART                 YEARLY        TOTAL
    NAME               INDUCTIONS   HOURS NEEDED
-------------------------------------------------

2ND.STG.DIFF.ASSY      400.          193.20
BEARING HSG.           400.          225.96
TURBINE BRG. HSG.      400.           47.04

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    466.2000

                      TOTAL HOURS AVAILABLE:   2080.000

RESOURCE NAME:GRINDER

    PART                 YEARLY        TOTAL
    NAME               INDUCTIONS   HOURS NEEDED
-------------------------------------------------

BEARING HSG.           400.          747.60

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    747.6000

                      TOTAL HOURS AVAILABLE:   2080.000

RESOURCE NAME:JA09

    PART                 YEARLY        TOTAL
    NAME               INDUCTIONS   HOURS NEEDED
-------------------------------------------------

2ND.STG.DIFF.ASSY      400.         1200.00
BEARING HSG.           400.         1199.04
TURBINE BRG. HSG.      400.          133.20

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    2532.240

                      TOTAL HOURS AVAILABLE:   7348.250

RESOURCE NAME:LATHEA

    PART                 YEARLY        TOTAL
    NAME               INDUCTIONS   HOURS NEEDED
-------------------------------------------------

2ND.STG.DIFF.ASSY      400.          108.00

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    108.0000

                      TOTAL HOURS AVAILABLE:   2080.000

RESOURCE NAME:LATHEB

    PART                 YEARLY        TOTAL
    NAME               INDUCTIONS   HOURS NEEDED
-------------------------------------------------
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821

596

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BEARING HSG.           400.           361.76

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    361.7600

                      TOTAL HOURS AVAILABLE:   2080.000

RESOURCE NAME:LATHEC

    PART                 YEARLY         TOTAL
    NAME               INDUCTIONS    HOURS NEEDED
-------------------------------------------------

TURBINE BRG. HSG.      400.           108.00

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    108.0000

                      TOTAL HOURS AVAILABLE:   2080.000

RESOURCE NAME:OVEN

    PART                 YEARLY         TOTAL
    NAME               INDUCTIONS    HOURS NEEDED
-------------------------------------------------

2ND.STG.DIFF.ASSY      400.           180.00

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    180.0000

                      TOTAL HOURS AVAILABLE:   12480.00

RESOURCE NAME:PT05

    PART                 YEARLY         TOTAL
    NAME               INDUCTIONS    HOURS NEEDED
-------------------------------------------------

2ND.STG.DIFF.ASSY      400.            90.00
TURBINE BRG. HSG.      400.           112.20

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    202.2000

                      TOTAL HOURS AVAILABLE:   4198.350

RESOURCE NAME:RADL DR

    PART                 YEARLY         TOTAL
    NAME               INDUCTIONS    HOURS NEEDED
-------------------------------------------------

2ND.STG.DIFF.ASSY      400.           964.00

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    963.9999

                      TOTAL HOURS AVAILABLE:   2080.000

RESOURCE NAME:STRP TNK
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    PART                 YEARLY       TOTAL
    NAME               INDUCTIONS  HOURS NEEDED
-----------------------------------------------

TURBINE BRG. HSG.       400.          34.20

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    34.20000

                     TOTAL HOURS AVAILABLE:   2080.000

RESOURCE NAME:UA09

    PART                 YEARLY       TOTAL
    NAME               INDUCTIONS  HOURS NEEDED
-----------------------------------------------

BEARING HSG.            400.           6.00
TURBINE BRG. HSG.       400.         103.20

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    109.2000

                     TOTAL HOURS AVAILABLE:   7351.500

RESOURCE NAME:WELDER

    PART                 YEARLY       TOTAL
    NAME               INDUCTIONS  HOURS NEEDED
-----------------------------------------------

2ND.STG.DIFF.ASSY       400.         730.40
BEARING HSG.            400.          60.84

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    791.2400

                     TOTAL HOURS AVAILABLE:   2080.000

RESOURCE NAME:WJ09

    PART                 YEARLY       TOTAL
    NAME               INDUCTIONS  HOURS NEEDED
-----------------------------------------------

2ND.STG.DIFF.ASSY       400.         180.00
TURBINE BRG. HSG.       400.          45.00

   TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    225.0000

                     TOTAL HOURS AVAILABLE:   8837.400

RESOURCE NAME:WK09

    PART                 YEARLY       TOTAL
    NAME               INDUCTIONS  HOURS NEEDED
-----------------------------------------------

2ND.STG.DIFF.ASSY       400.         324.00
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823

598

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TURBINE BRG. HSG.      400.          91.44

    TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    415.4400

                  TOTAL HOURS AVAILABLE:   1465.750

RESOURCE NAME:WI09

    PART               YEARLY        TOTAL
    NAME             INDUCTIONS   HOURS NEEDED
----------------------------------------------

2ND.STG.DIFF.ASSY      400.          406.40
BEARING HSG.           400.          192.84

    TOTAL HOURS NEEDED TO PROCESS ALL PARTS:    599.2401

                  TOTAL HOURS AVAILABLE:   1465.750
```

599

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ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL       PAGE:   1
------------------------------------------------------------------------------------------------------
RUN PARAMETERS
--------------
 UDOS    :
This job was run on SAALC - 780 VAX at San Antonio.

 ALC:  SA

 RCC:  MATPGB

 REPORT ID:  CELL

        GTE LINE - MACHINE CELL

 PART FILE:  GTEPART.CEL
 RES  FILE:  GTERES.CEL
 OPER FILE:  GTEOPS.CEL
 ETC  FILE:  GTEETC.CEL

 WEEKENDS - Y

 NUMBER OF QUARTERS -            4

 WARM UP PERIOD; STATS WILL BE CLEARED AT DAY         364

 # OF HOLIDAYS                    0

 HISTORICAL DATA SHIFT FACTOR   8.000000

 BACKSHOP DATA SHIFT FACTOR     24.00000

 NEW DATA FORMATS SELECTED


SIMULATION CPU TIME:     228.43 MINUTES
SIMULATION LAPSE TIME:   725.11 MINUTES

SIMULATION RUN LENGTH: 17472.00 HOURS

Number of Items      :        5
Number of Resources  :       19
Number of WCDs       :        5
Number of Operations :      121
Operations completed :   126168
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL       PAGE:   2
------------------------------------------------------------------------------------------------------
 ITEM INDUCTIONS
 ---------------
                                         1ST QTR  2ND QTR  3RD QTR  4TH QTR      YTD
                                        -------- -------- -------- -------- --------
INDUCTIONS OF ITEM 2ND.STG.DIFF.ASSY :      300      300      300      300     1200    (MISTR)
INDUCTIONS OF ITEM BEARING HSG.      :      300      300      300      300     1200    (MISTR)
INDUCTIONS OF ITEM GTE -180          :      300      300      300      300     1200    (MISTR)
INDUCTIONS OF ITEM GTE -397          :      300      300      300      300     1200    (MISTR)
INDUCTIONS OF ITEM TURBINE BRG. HSG. :      300      300      300      300     1200    (MISTR)

-------------------------------------------------------------------------------------
TOTAL ITEM INDUCTIONS                :     1500     1500     1500     1500     6000
```

SURGE WORKLOAD
THRU MACHINE CELL

825

600

60-1

```
ALC:  SA    RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:    3
------------------------------------------------------------------------------------------------------
 WCD INDUCTIONS
 --------------
                                              1ST QTR  2ND QTR  3RD QTR  4TH QTR      YTD
                                              -------  -------  -------  -------  -------
INDUCTIONS OF WCD            TA813F  :          300      300      300      300     1200
INDUCTIONS OF WCD            TG631D  :          300      300      300      300     1200
INDUCTIONS OF WCD            13095A  :          300      300      300      300     1200
INDUCTIONS OF WCD            13094A  :          300      300      300      300     1200
INDUCTIONS OF WCD            TG847F  :          300      300      300      300     1200
-------------------------------------------------------------------------------------------
TOTAL WCD INDUCTIONS                 :         1500     1500     1500     1500     6000

ALC:  SA    RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:    4
------------------------------------------------------------------------------------------------------
FLOW CYCLE TIME STATISTICS
--------------------------
                                     AVERAGE                SIMULATED  SIMULATED
                      HISTORICAL    SIMULATED                MINIMUM    MAXIMUM    NUMBER    NUMBER
                       FLOWTIME     FLOW TIME   STANDARD    FLOW TIME  FLOW TIME     OF        OF
 ITEM                   HOURS         HOURS     DEVIATION     HOURS      HOURS     SAMPLES  INDUCTIONS
-----------------     ----------    -------    ---------    -------    -------    -------   ----------

2ND.STG.DIFF.ASSY       3240.00     6543.57     1520.69     3386.70   10134.00       597      1200
BEARING HSG.            2714.40     4448.63     1588.37        7.29    8695.31       747      1200
GTE -180                   0.00     4700.23      963.12     3003.83    6363.78       747      1200
GTE -397                   0.00     6669.68     1292.94     4467.23    8836.38       597      1200
TURBINE BRG. HSG.       2496.00       75.80       61.31        1.72     483.36      1197      1200
ALC:  SA    RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:    5
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DIRECT LABOR STATISTICS
-----------------------
                                                   SIMULATED                  SIMULATED    SIMULATED
                                                    AVERAGE                    MINIMUM      MAXIMUM    NUMBER
                          EXPECTED   STANDARD        LABOR       STANDARD       LABOR        LABOR       OF
 ITEM                       HOURS      HOURS         HOURS       DEVIATION      HOURS        HOURS     SAMPLES
-----------------         --------   --------       -------     ----------     -------      -------    -------

2ND.STG.DIFF.ASSY           5.98      32.40          5.99          0.59          3.49         6.58       597
BEARING HSG.                4.06      27.14          3.89          1.40          0.46         8.51       747
GTE -180                    0.00       0.00          0.00          0.00          0.00         0.00       747
GTE -397                    0.00       0.00          0.00          0.00          0.00         0.00       597
TURBINE BRG. HSG.           1.33      24.96          1.29          0.95          0.00         5.12      1197
ALC:  SA    RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:    6
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BACKSHOP DWELL SUMMARY
----------------------
                        AVERAGE                 SIMULATED  SIMULATED
                       SIMULATED                 MINIMUM    MAXIMUM   NUMBER
                       BACKSHOP    STANDARD     BACKSHOP   BACKSHOP     OF
 ITEM                    HOURS     DEVIATION      HOURS      HOURS    SAMPLES
-----------------      --------   ----------    --------   -------    -------
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826

602

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2ND.STG.DIFF.ASSY        94.90      40.58      10.91     280.63       597
BEARING HSG.              8.77       8.08       0.54     130.73       747
GTE -180                  0.00       0.00       0.00       0.00       747
GTE -397                  0.00       0.00       0.00       0.00       597
TURBINE BRG. HSG.        50.16      52.11       0.00     473.73      1197

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL       PAGE:    7
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PROCESS TIMES SUMMARY
---------------------

                         HISTOR.   SIMULATED    WAITING FOR                                              NUMBER
                          FLOW       FLOW       RESOURCES          PROCESSING FLOW      BACKSHOP           OF
 ITEM                     HOURS      HOURS      HOURS      %       HOURS     %        HOURS     %       SAMPLES
-----------------        -------   ---------    ------   ------    -----   ----       -----   -----     -------

2ND.STG.DIFF.ASSY        3240.0      6543.6     6419.3    98.1%     29.4    0.4%       94.9    1.5%        597
BEARING HSG.             2714.4      4448.6     4418.3    99.3%     21.5    0.5%        8.8    0.2%        747
GTE -180                    0.0      4700.2     4700.2   100.0%      0.0    0.0%        0.0    0.0%        747
GTE -397                    0.0      6669.7     6669.7   100.0%      0.0    0.0%        0.0    0.0%        597
TURBINE BRG. HSG.        2496.0        75.8       23.4    30.9%      2.2    2.9%       50.2   66.2%       1197

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL       PAGE:    8
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 RESOURCE QUEUE STATISTICS
------------------------

                AVERAGE               MAXIMUM    AVERAGE       CURRENT     THE
RESOURCE        QUEUE     STANDARD    QUEUE      QUEUE         QUEUE       BLAKE
QUEUE           QUANTITY  DEVIATION   QUANTITY   WAIT(hrs)     QUANTITY    STATISTIC
--------        --------  ---------   --------   ---------     --------    ---------

BOOTH     EQ       0.09       0.49      21.00        0.42            0         0.04
CHRM TNK  EQ       0.02       0.15       4.00        0.77            0         0.02
DB09      MP       2.17       1.87      16.00        8.20            2        17.75
DRILL PR  EQ       0.05       0.43      10.00        0.23            0         0.01
FPI       EQ       0.67       1.76      16.00        0.44            5         0.30
GRINDER   EQ     584.66     211.74     866.00        4.89          865      2861.73
JA09      MP      71.54     222.73    1127.00        0.70           19        50.23
LATHEA    EQ       0.02       0.18       7.00        0.21            0         0.00
LATHEB    EQ       0.27       0.59       4.00        3.57            1         0.97
LATHEC    EQ       0.01       0.14       4.00        0.64            0         0.01
OVEN      EQ       0.04       0.22       2.00        0.52            0         0.02
PT05      MP       3.16       3.50      22.00       12.42           10        39.30
RADL DR   EQ     185.57      62.59     258.00        5.38          245       999.08
STRP TNK  EQ       0.00       0.05       3.00        0.12            0         0.00
UA09      MP       0.19       0.52       5.00        6.96            1         1.34
WELDER    EQ     618.05     270.20     946.00        5.08          945      3140.82
WJ09      MP       1.36       1.59       8.00       10.91            2        14.81
WK09      MP      85.01     224.74     916.00        0.68            4        57.95
WI09      MP       6.21      13.77      57.00        0.83            0         5.15

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL       PAGE:    9
------------------------------------------------------------------------------------------------------
ASSEMBLY STATISTICS
------------------

                                               WAIT
                          TOTAL   DELAYED     (HOURS)   -------WAITING QUEUE COUNT -----
PARENT ITEM               INDUCT  OPERATIONS  AVERAGE   AVERAGE  STD.DEV.  MAXIMUM  CURRENT
-----------               ------  ----------  -------   -------  --------  -------  -------
```

827

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GTE -180            1200         1200   4694.3     644.8     133.2   879.0     875
GTE -397            1200         1200   6698.7     920.2     174.0  1216.0    1214

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:   12:04:52  REPT.ID: CELL       PAGE:   10
-----------------------------------------------------------------------------------------------------------
WORK IN PROCESS
---------------

                                                                          AVERAGE  AVERAGE  CURRENT
                 ALLOWABLE                                                WAITING  QUANTITY QUANTITY
ITEM             QUANTITY  AVERAGE  STD.DEV. MINIMUM  MAXIMUM   CURRENT   TIME     WAITING  WAITING
------------     --------  -------- -------- -------- --------  -------   -------- -------- --------
2ND.STG.DIFF.ASSY 99999     920.2    174.0     611      1216     1214       ** NONE WAITED **
BEARING HSG.      99999     644.8    133.2     422       879      875       ** NONE WAITED **
GTE -180          99999     644.8    133.2     422       879      875       ** NONE WAITED **
GTE -397          99999     920.2    174.0     611      1216     1214       ** NONE WAITED **
TURBINE BRG. HSG. 99999      10.4      3.2       2        26       14       ** NONE WAITED **

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:   12:04:52  REPT.ID: CELL       PAGE:   11
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DEDICATED STOCK STATISTICS - Parallel Operations
---------------------------------------------------

                                        WAIT
                  TOTAL   DELAYED     (HOURS)   -------WAITING QUEUE COUNT------
STOCK ITEM        INDUCT  OPERATIONS  AVERAGE   AVERAGE  STD.DEV. MAXIMUM CURRENT
----------        ------  ----------  -------   -------  -------- ------- -------

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:   12:04:52  REPT.ID: CELL       PAGE:   12
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FLOATING STOCK STATISTICS
-------------------------

                    FLOATING
                     STOCK   -QUANTITY  IN STOCK & AVAILABLE FOR ASSEMBLY-
STOCK ITEM          QUANTITY  AVERAGE  STD.DEV. MINIMUM  MAXIMUM  CURRENT
-----------         --------  -------  -------- -------- -------- -------
2ND.STG.DIFF.ASSY          0     0.00     0.00     0.00     0.00        0
BEARING HSG.               0     0.00     0.00     0.00     0.00        0
TURBINE BRG. HSG.          0   909.73   174.41   600.00  1200.00     1200

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:   12:04:52  REPT.ID: CELL       PAGE:   13
-----------------------------------------------------------------------------------------------------------
 RESOURCE UTILIZATION by SHIFT
 ---------------------------

                                         ----AVERAGE NUMBER IN EACH STATE-----        ------BATCHING------
                          NUMBER  SHIFT                  PREV.             OTHER      MIN     MAX     AVG      AVG
CODE     DESCRIPTION SHIFT AVAIL.  UTIL.   IDLE  IN USE  MAINT.  FAILURE   DOWN       SIZE    SIZE    SIZE     PARTS   COUNT
------------------- ----- ------  -----   ----  ------  ------  -------   -----      ------  ------  ------   ------  -----
BOOTH    PNT          1    1.0    0.12   0.87    0.12    0.01     0.00    0.00       1.00   20.00    1.79     1.79    875
BATCH S2     1 /   20  2    0.0  NO VALUES RECORDED
                      3    0.0  NO VALUES RECORDED
                      4    0.0  NO VALUES RECORDED
                      5    0.0  NO VALUES RECORDED
                      6    0.0  NO VALUES RECORDED

CHRM TNK TNK          1    1.0    0.09   0.90    0.09    0.01     0.00    0.00       1.00    4.00    1.06     1.06    165
BATCH S2     1 /   10  2    0.0  NO VALUES RECORDED
                      3    0.0  NO VALUES RECORDED
                      4    0.0  NO VALUES RECORDED
                      5    0.0  NO VALUES RECORDED
```

828

603

```
                        6    0.0  NO VALUES RECORDED

DB09    MACH            1    2.0    0.37  0.45   0.26    0.00     0.00     0.29
                        2    0.0  NO VALUES RECORDED
                        3    0.0  NO VALUES RECORDED
                        4    0.0  NO VALUES RECORDED
                        5    0.0  NO VALUES RECORDED
                        6    0.0  NO VALUES RECORDED

DRILL PR DRILL          1    1.0    0.19  0.81   0.18    0.00     0.00     0.00
                        2    0.0  NO VALUES RECORDED
                        3    0.0  NO VALUES RECORDED
                        4    0.0  NO VALUES RECORDED
                        5    0.0  NO VALUES RECORDED
                        6    0.0  NO VALUES RECORDED

FPI     FPI             1    1.0    0.52  0.48   0.52    0.00     0.00     0.00
                        2    0.0  NO VALUES RECORDED
                        3    0.0  NO VALUES RECORDED
                        4    0.0  NO VALUES RECORDED
                        5    0.0  NO VALUES RECORDED
                        6    0.0  NO VALUES RECORDED

GRINDER GRND            1    1.0    0.70  0.30   0.70    0.00     0.00     0.00
                        2    0.0  NO VALUES RECORDED
                        3    0.0  NO VALUES RECORDED
                        4    0.0  NO VALUES RECORDED
                        5    0.0  NO VALUES RECORDED
                        6    0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources.

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:   14
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 RESOURCE UTILIZATION by SHIFT
 ----------------------------

                                                ----AVERAGE NUMBER IN EACH STATE-----         ------BATCHING------
                            NUMBER  SHIFT                       PREV.             OTHER       MIN      MAX      AVG      AVG
CODE      DESCRIPTION  SHIFT AVAIL.  UTIL.    IDLE   IN USE    MAINT.  FAILURE    DOWN        SIZE     SIZE     SIZE     PARTS   COUNT
-----------------------  -----  ------  -----    ----   ------    ------  -------    -----       ------   ------   ------   ------  -----
JA03      MACH            1    5.0    0.68  0.23   0.48    0.00     0.00     0.29
                          2    0.0  NO VALUES RECORDED
                          3    0.0  NO VALUES RECORDED
                          4    0.0  NO VALUES RECORDED
                          5    0.0  NO VALUES RECORDED
                          6    0.0  NO VALUES RECORDED

LATHEA    LATHE           1    1.0    0.09  0.91   0.09    0.00     0.00     0.00
                          2    0.0  NO VALUES RECORDED
                          3    0.0  NO VALUES RECORDED
                          4    0.0  NO VALUES RECORDED
                          5    0.0  NO VALUES RECORDED
                          6    0.0  NO VALUES RECORDED

LATHEB    LATHE           1    1.0    0.39  0.60   0.39    0.00     0.00     0.00
                          2    0.0  NO VALUES RECORDED
                          3    0.0  NO VALUES RECORDED
                          4    0.0  NO VALUES RECORDED
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829

604

```
                            5     0.0  NO VALUES RECORDED
                            6     0.0  NO VALUES RECORDED

LATHEC    LATHE             1     1.0    0.16   0.84    0.16    0.00     0.00     0.00
                            2     0.0  NO VALUES RECORDED
                            3     0.0  NO VALUES RECORDED
                            4     0.0  NO VALUES RECORDED
                            5     0.0  NO VALUES RECORDED
                            6     0.0  NO VALUES RECORDED

OVEN      OVEN              1     6.0    0.03   0.97    0.03    0.00     0.00     0.00         1.00      1.00      1.00      1.00     644
BATCH SZ      1 /    6      2     0.0  NO VALUES RECORDED
                            3     0.0  NO VALUES RECORDED
                            4     0.0  NO VALUES RECORDED
                            5     0.0  NO VALUES RECORDED
                            6     0.0  NO VALUES RECORDED

PT05      PAINT             1     3.0    0.06   0.63    0.04    0.00     0.00     0.33
                            2     0.0  NO VALUES RECORDED
                            3     0.0  NO VALUES RECORDED
                            4     0.0  NO VALUES RECORDED
                            5     0.0  NO VALUES RECORDED
                            6     0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources.

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:  15
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 RESOURCE UTILIZATION by SHIFT
 -----------------------------
                                               ----AVERAGE NUMBER IN EACH STATE-----         ------BATCHING------
                            NUMBER  SHIFT                     PREV.              OTHER       MIN       MAX       AVG       AVG
CODE      DESCRIPTION  SHIFT AVAIL.  UTIL.    IDLE   IN USE  MAINT.  FAILURE     DOWN       SIZE      SIZE      SIZE     PARTS   COUNT
-------------------    ----- ------  -----    ----   ------  ------  -------    -----      ------    ------    ------    ------   -----
RADL DR   DRILL             1     1.0    0.70   0.30    0.70    0.00     0.00     0.00
                            2     0.0  NO VALUES RECORDED
                            3     0.0  NO VALUES RECORDED
                            4     0.0  NO VALUES RECORDED
                            5     0.0  NO VALUES RECORDED
                            6     0.0  NO VALUES RECORDED

STRP TNK  TNK               1     1.0    0.05   0.95    0.05    0.00     0.00     0.00         1.00      3.00      1.03      1.03     115
BATCH SZ      1 /   10      2     0.0  NO VALUES RECORDED
                            3     0.0  NO VALUES RECORDED
                            4     0.0  NO VALUES RECORDED
                            5     0.0  NO VALUES RECORDED
                            6     0.0  NO VALUES RECORDED

UA09      PLATE             1     5.0    0.04   0.68    0.03    0.00     0.00     0.29
                            2     0.0  NO VALUES RECORDED
                            3     0.0  NO VALUES RECORDED
                            4     0.0  NO VALUES RECORDED
                            5     0.0  NO VALUES RECORDED
                            6     0.0  NO VALUES RECORDED

WELDER    WELD              1     1.0    0.69   0.31    0.69    0.00     0.00     0.00
                            2     0.0  NO VALUES RECORDED
                            3     0.0  NO VALUES RECORDED
```

```
                      4   0.0  NO VALUES RECORDED
                      5   0.0  NO VALUES RECORDED
                      6   0.0  NO VALUES RECORDED

WJ09     HT           1   6.0    0.05   0.67   0.04    0.00    0.00    0.29
                      2   0.0  NO VALUES RECORDED
                      3   0.0  NO VALUES RECORDED
                      4   0.0  NO VALUES RECORDED
                      5   0.0  NO VALUES RECORDED
                      6   0.0  NO VALUES RECORDED

WK09     WELD         1   1.0    0.62   0.27   0.44    0.00    0.00    0.30
                      2   0.0  NO VALUES RECORDED
                      3   0.0  NO VALUES RECORDED
                      4   0.0  NO VALUES RECORDED
                      5   0.0  NO VALUES RECORDED
                      6   0.0  NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources.

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:  16
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 RESOURCE UTILIZATION by SHIFT
 ----------------------------
                                            ----AVERAGE NUMBER IN EACH STATE-----       ------BATCHING------
                             NUMBER  SHIFT                   PREV.           OTHER     MIN     MAX     AVG     AVG
CODE     DESCRIPTION   SHIFT AVAIL.  UTIL.   IDLE   IN USE  MAINT.  FAILURE   DOWN     SIZE    SIZE    SIZE    PARTS  COUNT
------------------     ----- ------  -----   ----   ------  ------  -------   -----    ------  ------  ------  ------ -----
WI09     WELD           1    1.0     0.76   0.17   0.53    0.00    0.00     0.30
                        2    0.0   NO VALUES RECORDED
                        3    0.0   NO VALUES RECORDED
                        4    0.0   NO VALUES RECORDED
                        5    0.0   NO VALUES RECORDED
                        6    0.0   NO VALUES RECORDED

 Note:  Remember that the utilizations reflect
        only 80% of the workload and the other
        20% may not be spread evenly across all
        resources

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:  17
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 ITEM NAME: 2ND.STG.DIFF.ASSY  WCD NAME: TA813F

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                          AVERAGE      AVERAGE
 OPER  POTENTIAL PROCESSED     QUEUED    QUEUED      SCHEDULED    SIMULATED                    OCC
 CODE     QTY       QTY          QTY       HRS          HRS          HRS      DESC   RCC      FAC
 ----  --------  --------   ----------  --------   ----------   ----------   ----   ------   ----
 0100    1200.     1200.           0.      0.00         2.02         2.02    IN     MATPNC   1.00
 0140    1200.     1200.        1088.      2.88         0.32         0.43    PROC   MATPNC   1.00  JA09,DRILLPR
 0199    1200.     1200.           0.      0.00         0.00         0.00    OUT    MATPNC   1.00
 0200    1200.     1092.           0.      0.00         1.00         1.00    IN     MATPNB   0.90
 0240    1200.     1076.         854.      5.48         0.21         0.65    PROC   MATPNB   0.90  DB09,FPI
 0299    1196.     1093.           0.      0.00         0.00         0.00    OUT    MATPNB   0.90
```

```
0300   1196.    1067.      0.        0.00       1.00        1.00      IN    MATPNN  0.90
0340   1196.    1103.    612.     5232.29       0.90        6.35      PROC  MATPNN  0.90  WK09,WELDER
0399    705.     625.      0.        0.00       0.00        0.00      OUT   MATPNN  0.90
0400    705.     638.      0.        0.00      24.80       24.80      IN    MAEPDB  0.90
0440    705.     644.    478.       22.85       0.50        1.14      PROC  MAEPDB  0.90  WJ09,OVEN(be)
0499    705.     642.      0.        0.00       8.99        8.99      OUT   MAEPDB  0.90
0500    705.     638.      0.        0.00       0.98        0.98      IN    MATPNC  0.90
0540    705.     637.    571.       21.94       0.30        0.61      PROC  MATPNC  0.90  JA09,LATHEA
0599    707.     641.      0.        0.00       0.00        0.00      OUT   MATPNC  0.90
0600    707.     641.      0.        0.00       0.94        0.94      IN    MATPNB  0.90
0640    707.     638.    550.        3.50       0.21        0.32      PROC  MATPNB  0.90  DB09,FPI
0699    708.     640.      0.        0.00       0.00        0.00      OUT   MATPNB  0.90
0700    708.     552.      0.        0.00       1.00        1.00      IN    MATPNN  0.80
0740    708.     581.    595.      571.98       1.27        6.79      PROC  MATPNN  0.80  WI09,WELDER
0799    722.     574.      0.        0.00       0.00        0.00      OUT   MATPNN  0.80
0800    722.     722.      0.        0.00       1.02        1.02      IN    MATPNC  1.00
0840    722.     722.    639.     1811.54       0.30        2.54      PROC  MATPNC  1.00  JA09,RADLDR
0899    639.     639.      0.        0.00       0.00        0.00      OUT   MATPNC  1.00
0900    639.     315.      0.        0.00       0.99        0.99      IN    MATPNB  0.50
0940    639.     309.    242.        4.19       0.21        1.84      PROC  MATPNB  0.50  DB09,FPI
0999    639.     322.      0.        0.00       0.00        0.00      OUT   MATPNB  0.50
1000    639.     572.      0.        0.00      24.83       24.72      IN    MATPMM  0.90
1040    638.     569.    441.       24.84       0.25        0.53      PROC  MATPMM  0.90  PT05,BOOTH(be)
1099    635.     576.      0.        0.00      34.20       34.27      OUT   MATPMM  0.90
1100    636.     636.      0.        0.00       2.18        2.18      IN    MATPNC  1.00
1140    636.     636.    597.      612.77       2.11       11.88      PROC  MATPNC  1.00  JA09,RADLDR
1199    597.     597.      0.        0.00       0.00        0.00      OUT   MATPNC  1.00
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL     PAGE:   18
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 ITEM NAME: BEARING HSG.      WCD NAME:  TG631D

WCD by OPERATION STATISTIC AVERAGES
-----------------------------------
                                                   AVERAGE      AVERAGE
 OPER  POTENTIAL PROCESSED    QUEUED     QUEUED   SCHEDULED    SIMULATED                    OCC
 CODE     QTY       QTY        QTY        HRS        HRS          HRS        DESC   RCC     FAC
 ----  --------  --------  ----------  --------  ----------  ----------    ----  ------  ----
 0100   1200.      689.        0.        0.00       1.90        1.90      IN    MATPNC  0.59
 0140   1200.      729.      671.        2.40       0.38        0.41      PROC  MATPNC  0.59  JA09
 0199   1200.      725.        0.        0.00       0.00        0.00      OUT   MATPNC  0.59
 0200   1200.       64.        0.        0.00       1.05        1.05      IN    MATPNB  0.05
 0240   1200.       60.       55.        2.17       0.21        0.21      PROC  MATPNB  0.05  DB09,FPI
 0299   1200.       72.        0.        0.00       0.00        0.00      OUT   MATPNB  0.05
 0300   1200.      266.        0.        0.00       1.07        1.07      IN    MATPNC  0.23
 0340   1200.      267.      185.     4272.45       1.05        6.98      PROC  MATPNC  0.23  JA09,GRINDER
 0399   1125.      245.        0.        0.00       0.00        0.00      OUT   MATPNC  0.23
 0400   1125.      851.        0.        0.00       0.99        0.99      IN    MATPNB  0.77
 0440   1125.      862.      730.        3.34       0.21        0.57      PROC  MATPNB  0.77  DB09,FPI
 0499   1125.      896.        0.        0.00       0.00        0.00      OUT   MATPNB  0.77
 0500   1125.      821.        0.        0.00       1.02        1.02      IN    MATPNN  0.73
 0540   1125.      846.      378.        5.22       0.25        0.82      PROC  MATPNN  0.73  WI09
 0599   1125.      823.        0.        0.00       0.00        0.00      OUT   MATPNN  0.73
 0600   1125.      841.        0.        0.00       0.97        0.97      IN    MATPNC  0.73
 06     1125.      809.      630.     3681.79       1.05        6.49      PROC  MATPNC  0.73  JA09,GRINDER
 06      947.      672.        0.        0.00       0.00        0.00      OUT   MATPNC  0.73
 070     947.      690.        0.        0.00       1.06        1.06      IN    MATPNB  0.73
 0740       .      693.      506.        6.64       0.21        1.56      PROC  MATPNB  0.73  DB09,FPI
 0799       .      681.        0.        0.00       0.00        0.00      OUT   MATPNB  0.73
 0800  [illegible]  656.       0.        0.00       0.98        0.98      IN    MATPNC  0.68
```

```
0840    946.    661.    422.    13.22    0.84     4.96   PROC  MATPNC  0.68  JA09,LATHEB
0899    945.    632.      0.     0.00    0.00     0.00   OUT   MATPNC  0.68
0900    945.      6.      0.     0.00   60.59    60.59   IN    MAEIAA  0.01
0940    945.     10.      2.     0.78    1.50     5.14   PROC  MAEIAA  0.01  UA09,CHRMTNK(be)
0999    945.     11.      0.     0.00   21.99    21.99   OUT   MAEIAA  0.01
1000    945.    642.      0.     0.00    0.98     0.98   IN    MATPNC  0.68
1040    945.    657.    476.  1886.35    1.05     6.27   PROC  MATPNC  0.68  JA09,GRINDER
1099    766.    536.      0.     0.00    0.00     0.00   OUT   MATPNC  0.68
1100    766.     71.      0.     0.00    0.90     0.90   IN    MATPNN  0.09
1140    766.     70.     71.   592.08    1.69    11.85   PROC  MATPNN  0.09  WI09,WELDER
1199    767.     79.      0.     0.00    0.00     0.00   OUT   MATPNN  0.09
1200    767.    100.      0.     0.00    1.04     1.04   IN    MATPNC  0.14
1240    767.    100.     48.  1603.66    1.05     3.89   PROC  MATPNC  0.14  JA09,GRINDER
1299    746.    102.      0.     0.00    0.00     0.00   OUT   MATPNC  0.14
1300    746.    474.      0.     0.00    0.97     0.97   IN    MATPNB  0.64
1340    746.    473.    349.     6.73    0.21     1.29   PROC  MATPNB  0.64  DB09,FPI
1399    746.    492.      0.     0.00    0.00     0.00   OUT   MATPNB  0.64
1400    746.    441.      0.     0.00    1.02     1.02   IN    MATPNN  0.59
1440    746.    449.    222.     9.37    0.25     1.78   PROC  MATPNN  0.59  WI09
1499    747.    433.      0.     0.00    0.00     0.00   OUT   MATPNN  0.59
1500    747.    114.      0.     0.00    1.00     1.00   IN    MATPNC  0.14
1540    747.    110.     66.     9.40    2.38    13.46   PROC  MATPNC  0.14  JA09,LATHEB
1599    747.    128.      0.     0.00    0.00     0.00   OUT   MATPNC  0.14
1600    747.    357.      0.     0.00    1.12     1.12   IN    MATPNB  0.50
1640    747.    389.    296.     7.76    0.21     0.71   PROC  MATPNB  0.50  DB09,FPI
1699    747.    390.      0.     0.00    0.00     0.00   OUT   MATPNB  0.50
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:  19
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 ITEM NAME: GTE -18C          WCD NAME: 13095A

WCD by OPERATION STATISTIC AVERAGES
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                                                  AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED    QUEUED   SCHEDULED   SIMULATED                  OCC
 CODE     QTY       QTY        QTY       HRS        HRS         HRS       DESC   RCC    FAC
 ----  --------  --------  ----------  --------  ----------  ----------   ----  ------  ----
 0000   1200.     1200.        0.        0.00      0.00        0.00      IN    MATPGB  1.00
 0010   1200.     1200.        0.        0.00      0.00        0.00      DIS   MATPGB  1.00
 0020   1200.     1200.        0.        0.00      0.00        0.00      KIT   MATPGB  1.00
 0030   1200.     1200.      747.     4700.23      0.00        0.00      ASSY  MATPGB  1.00  ,as
 0099    747.      747.        0.        0.00      0.00        0.00      OUT   MATPGB  1.00
ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:  20
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 ITEM NAME: GTE -397          WCD NAME: 13094A

WCD by OPERATION STATISTIC AVERAGES
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                                                  AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED   QUEUED    QUEUED   SCHEDULED   SIMULATED                  OCC
 CODE     QTY       QTY        QTY       HRS        HRS         HRS       DESC   RCC    FAC
 ----  --------  --------  ----------  --------  ----------  ----------   ----  ------  ----
 0000   1200.     1200.        0.        0.00      0.00        0.00      IN    MATPGB  1.00
 0010   1200.     1200.        0.        0.00      0.00        0.00      DIS   MATPGB  1.00
 0020   1200.     1200.        0.        0.00      0.00        0.00      KIT   MATPGB  1.00
 0030   1200.     1200.      597.     6669.68      0.00        0.00      ASSY  MATPGB  1.00  ,as
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 0099      597.      597.          0.          0.00        0.00         0.00      OUT    MATPGB   1.00

ALC:  SA   RCC:  MATPGB  QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:   21
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 ITEM NAME: TURBINE BRG. HSG.  WCD NAME: TG847F

WCD by OPERATION STATISTIC AVERAGES
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                                                            AVERAGE     AVERAGE
 OPER  POTENTIAL PROCESSED     QUEUED    QUEUED    SCHEDULED   SIMULATED                   OCC
 CODE     QTY       QTY          QTY       HRS        HRS         HRS      DESC   RCC      FAC
 ----  --------  --------   ---------- --------   ----------  ----------   ----  ------   ----
 0100    1200.      439.          0.       0.00       1.81        1.81     IN    MATPNC   0.35
 0140    1200.      413.        392.       2.27       0.18        0.18     PROC  MATPNC   0.35  JA09
 0199    1200.      438.          0.       0.00       0.00        0.00     OUT   MATPNC   0.35
 0200    1200.      100.          0.       0.00      25.35       25.35     IN    MAEIAA   0.09
 0240    1200.      119.         75.       4.91       0.95        0.95     PROC  MAEIAA   0.09  UA09,STRPTNK(be)
 0299    1200.       89.          0.       0.00      32.59       32.59     OUT   MAEIAA   0.09
 0300    1200.       80.          0.       0.00       0.99        0.99     IN    MATPNC   0.06
 0340    1200.       70.         48.       7.80       1.00        1.27     PROC  MATPNC   0.06  JA09,LATHEC
 0399    1200.       76.          0.       0.00       0.00        0.00     OUT   MATPNC   0.06
 0400    1200.      268.          0.       0.00       0.99        0.99     IN    MATPNB   0.21
 0440    1200.      250.        234.       4.07       0.21        0.21     PROC  MATPNB   0.21  DB09,FPI
 0499    1201.      268.          0.       0.00       0.00        0.00     OUT   MATPNB   0.21
 0500    1201.      191.          0.       0.00      21.79       21.79     IN    MAEPDB   0.15
 0540    1201.      163.         87.      10.68       0.75        0.86     PROC  MAEPDB   0.15  WJ09
 0599    1202.      170.          0.       0.00      33.79       33.79     OUT   MAEPDB   0.15
 0600    1202.      187.          0.       0.00      71.76       71.62     IN    MAEIAA   0.15
 0640    1201.      165.        112.      11.97       1.15        1.89     PROC  MAEIAA   0.15  UA09,CHRMTNK(be)
 0699    1201.      172.          0.       0.00      31.92       31.92     OUT   MAEIAA   0.15
 0700    1201.      211.          0.       0.00       0.85        0.85     IN    MATPNN   0.18
 0740    1201.      215.        155.      11.62       1.27        2.64     PROC  MATPNN   0.18  WK09
 0799    1198.      226.          0.       0.00       0.00        0.00     OUT   MATPNN   0.18
 0800    1198.      252.          0.       0.00       1.06        1.06     IN    MATPNC   0.21
 0840    1198.      256.        164.      12.86       1.00        1.50     PROC  MATPNC   0.21  JA09,LATHEC
 0899    1197.      242.          0.       0.00       0.00        0.00     OUT   MATPNC   0.21
 0900    1197.      395.          0.       0.00       1.00        1.00     IN    MATPNB   0.35
 0940    1197.      404.        330.       7.22       0.21        0.58     PROC  MATPNB   0.35  DB09,FPI
 0999    1200.      401.          0.       0.00       0.00        0.00     OUT   MATPNB   0.35
 1000    1200.     1026.          0.       0.00      23.62       23.49     IN    MATPMM   0.85
 1040    1198.     1005.        769.      21.86       0.33        0.69     PROC  MATPMM   0.85  PT05,BOOTH(be)
 1099    1197.     1031.          0.       0.00       0.00        0.00     OUT   MATPMM   0.85
ALC:  SA   RCC:  MATPGB  QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:   22
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BACKSHOP DWELL TIMES BY BACKSHOP RCC
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                                           AVERAGE
ITEM                          RCC           HOURS
------------------         ---------      -------
2ND.STG.DIFF.ASSY           MATPNC           6.10
2ND.STG.DIFF.ASSY           MATPNB           2.25
2ND.STG.DIFF.ASSY           MATPNN           1.68
2ND.STG.DIFF.ASSY           MAEPDB          30.63
2ND.STG.DIFF.ASSY           MATPMM          53.22
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BEARING HSG.              MATPNC       3.69
BEARING HSG.              MATPNB       2.72
BEARING HSG.              MATPNN       1.43
BEARING HSG.              MAEIAA       0.64

GTE -180              *** NO BACKSHOP ACTIVITY *****

GTE -397              *** NO BACKSHOP ACTIVITY *****

TURBINE BRG. HSG.         MATPNC       0.95
TURBINE BRG. HSG.         MAEIAA      20.24
TURBINE BRG. HSG.         MATPNB       0.55
TURBINE BRG. HSG.         MAEPDB       8.24
TURBINE BRG. HSG.         MATPNN       0.15
TURBINE BRG. HSG.         MATPMM      20.09

ALC:  SA   RCC:  MATPGB   QUARTER:  4  DATE:  29-NOV-90  TIME:  12:04:52  REPT.ID: CELL      PAGE:   23
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HISTORICAL vs. SIMULATED COMPARISON
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                         HISTORICAL VALUES                     SIMULATED VALUES
                     FLOWTIME   STANDARD   SAMPLE    FLOWTIME   STANDARD   SAMPLE   WORKLOAD  PERCENTAGE
  ITEM                HOURS    DEVIATION    SIZE      HOURS    DEVIATION    SIZE     WEIGHT   DIFFERENCE
-----------------    -----------------------------   -----------------------------  --------  ----------
2ND.STG.DIFF.ASSY    3240.00       0.00       0      6543.57     1520.69    597      0.000      101.96
BEA.ING HSG.         2714.40       0.00       0      4448.63     1588.37    747      0.000       63.89
GTE -180                0.00       0.00       0      4700.23      963.12    747      0.000        0.00
GTE -397                0.00       0.00       0      6669.68     1292.94    597      0.000        0.00
TURBINE BRG. HSG.    2496.00       0.00       0        75.80       61.31   1197      0.000       96.96

ITEM 2ND.STG.DIFF.ASSY  EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

ITEM BEARING HSG.       EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

ITEM GTE -180           EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

ITEM GTE -397           EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

ITEM TURBINE BRG. HSG.  EXCLUDED FROM VALIDATION TEST DUE TO INSUFFICIENT DATA

NOT ENOUGH ITEMS REMAINING TO CONDUCT VALIDATION TEST

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ENGINEERING NOTES

EMPLOYEE GARDNER
DATE 6 DEC 90
PAGE NO.
RCC MATPSI/P&B
SUBJECT DSSY/INSPT COSTS

	-180	-397
DISASSEMBLY STNDRDS	8.68 HOURS	10.90 HOURS
INSPECTION STNDRDS	19.91 HOURS	8.54 HOURS
FPI STNDRDS	6.33 HOURS	5.67 HOURS
TOTAL	34.92 HOURS	25.11 HOURS

DDB SECTION CODE GFC 2.2
DDB PAGE NO.

Part flow - Sadie McFarland

The disassembly area for the GTEs is located at the N E end of bldg 329. The GTEs are brought into the disassembly area from an area NE of the building. Each operator disassembles a unit placing the parts on a flat bed cart. Expeditors move the cart to an area south of the new cleaning line and load the parts into modules, large cleaning baskets, that are sent to Bldg 360 ,MAEPNC, to be cleaned. If modules are not available the parts are placed on shelves in that same area.

When the modules are returned from bldg 360, the parts are unloaded and moved to the cleaning line in bldg 329 to complete the cleaning process. A low percentage of the parts require no further cleaning and are moved directly to inspection.

When the new cleaning line is complete the current parts flow will change. Operators will place their disassembled parts on the roller conveyor near their work station. The conveyor will move the parts to cleaning area where they are sorted, placed in wire baskets and moved to the cleaning line conveyor system. Baskets are color coded by attaching colored strips to the baskets. A few parts will still be sent to bldg 360/MAEPNC for cleaning but most will be cleaned there in bldg 329. MDMSC recommends the loading be done near the sort area.

After cleaning the parts are moved to another conveyor that moves them through inspection, FPI, MPI and into MATPSI for dimensional inspection. MATPSI completes the determination of the condition of the part and where the part will be sent next. The WCD is so marked and the parts are placed in plastic tubs and moved to the outgoing conveyor. The conveyor moves them the end of the conveyor near the N E end of the building where they wait for the expeditors to sort and move them. Some are to be scrapped, some are ready for the parts pool, but most must be moved to another RCC for repair.

Currently masking tape is placed on the edge of the tubs and after checking the WCDs, the expeditors sort the parts so that parts going to the same location are together then write this location on the tape. MDMSC recommends that the person marking the WCD for the next location also use color coding so that the expeditors do not have to open the plastic bags and hunt through the WCD to find where the part is to be sent.

Parts coming back into bldg 329 are returned to one location where, again, the expeditors sort the parts and move them to their next station. At this point most go to a parts pool. Again color coding could be used to advantage.

It was observed that station locations were not corrected when layouts were changed. Example: the return location for parts, in bldg 329, is D8. The containers were marked with B14. The expeditor stated that was the correct location before the new layout and that it sometimes took a long time for the WCD to be changed.

Inventory of the GTE stock room is now being maintained manually. Incoming parts are logged in and parts going into kits are logged out. There are plans to put this on the computer. Daily meeting keep the scheduler aware of part shortages. Kits are assembled three days before need. Scheduling and Expediting appeared to have a good working relationship.

There is an overhead system that is not in use, or so I was told.